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NORTH CAROLINA
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
WADE H. PHILLIPS, *Director*
THORNDIKE SAVILLE, *Chief Hydraulic Engineer*

ECONOMIC PAPER NUMBER 61

PRELIMINARY REPORT

ON THE

Chemical Quality of the Surface Waters of North Carolina With Relation to Industrial Use

BY

CHAS. E. RAY, JR.
Assistant Engineer
WATER RESOURCES DIVISION
N. C. DEPARTMENT OF CONSERVATION AND DEVELOPMENT

AND

E. E. RANDOLPH
Professor of Chemical Engineering
N. C. STATE COLLEGE OF AGRICULTURE AND ENGINEERING

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OWEN G. DUNN, PRINTER, NEW BERN, N. C.

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PREFACE

The vast water resources of North Carolina have long been recognized as important factors in the great hydro-electric development which has taken place in the State. That the chemical quality of these surface waters is of such a character as to make them unsurpassed for use in industrial processes requiring a water exceptionally free from chemical and physical impurities has until recently received only scant attention. It is this phase of the water resources of the State which is treated in the following pages.

The Department of Conservation and Development, through the Water Resources Division, presents herewith a "Preliminary Report on the Chemical Quality of the Surface Waters of North Carolina with Relation to Industrial Use". The report is presented at this time, not because the Department has finished a report on a completed study, but because there is an insistent demand both within the State and from without for information as to the chemical composition of our waters, and the Director of the Department feels that the information reported to date should be made available for the public in a readily accessible form. The need for the data has appeared so urgent that time has not been available to prepare this publication in the detail and in the finished form in which its compilers would like to have had it presented. However, every effort has been made to prevent inaccuracies of any kind, and it is believed that the data contained herein, although necessarily limited in its completeness, can be accepted as being free from error.

This publication, Economic Paper 61, presents 174 analyses of samples of surface waters and 11 analyses of samples of underground waters. Of these, 81 are from sources in the Mountain Section; 65 are from sources in the Piedmont Section; and 39 are from sources in the Coastal Plain Section. The Department desires to call attention to the unusually excellent chemical quality of these waters as reported in the following pages.

A great interconnected network, the most extensive in the world, is to be found here in the South. Hydro power can at need be relayed from Muscle Shoals and other Alabama power plants to eastern North Carolina, 600 miles distant. Similarly, steam power from the Tennessee, Alabama, and West Virginia coal fields can be made available in North Carolina.

However, the State is by no means dependent on other states for power in times of low stream flow, for in North Carolina, the power companies have a number of modern auxiliary steam plants of a total installed capacity of over 300,000 h. p. which will be increased by over 150,000 h. p. by 1929.

Within the State the developed industrial centers have an almost unlimited amount of electric power available, and from these centers high tension lines radiate out into the State either to neighboring centers or to isolated hydro plants to form a very comprehensive transmission system. At the present time practically every locality of the State, excepting certain portions in the extreme east and west, is being served from the interconnected system of the several Carolina power companies, or is within reach of such service. In both the eastern and western part of the State, it will be found that a number of important communities are being served by excellent municipal plants.

Realizing the inadequacy of a few paragraphs as a portrayal of the power facilities of the State, the extraordinary development of the high tension transmission system serving the State with its connected power stations is shown on Plate IV. In addition, the larger of the municipal plants with station ratings indicated have been shown. As indicated in the explanatory legend of Plate IV, the hydro plants are designated by means of circles and the steam plants by means of squares. The installed horsepower at all plants and the ownership of power plants and transmission lines are shown by appropriate symbols.

TRANSPORTATION SYSTEM

Three large railway systems have their trunk lines passing through the State from north to south, two of which are double tracked. Three railroads cross the State from east to west. These and other railroads, with their branch lines and con-

nections, form a network of over 5,000 miles of railroads providing railway connections for every county of the State. Of the 6,500 miles of State improved highways connecting every county seat, about 3,500 miles are hardsurfaced. Two of the most important seaports of the South Atlantic coast are in immediate touch with our industries. Over 1,000 miles of inland waterways maintained by the United States Government are available to serve vast areas of the Coastal and eastern part of the State, and completion of the Inland Waterway authorized by Congress will shortly assure additional advantages in protecting shipping in this great area.

LABOR SUPPLY

Those who are familiar with North Carolina do not need to be advised concerning her native labor resources. The people generally are intelligent, progressive, and industrious. Labor is not dominated by trade unions. Strikes and lockouts are practically unknown. Industrial riots have never occurred in the State. The fact that 95% of the population is native born tends to promote a common understanding.

EDUCATIONAL FACILITIES

With an excellent secondary system of schools as a ground work, the State has an admirable group of universities and colleges. Located at Chapel Hill in very nearly the geographic center of the State, the State University now in its 135th session is annually graduating large numbers of men from its professional schools of a caliber and training that make them particularly attractive as new material in the executive and administrative fields of employment. This applies particularly to the Commerce and Engineering Schools of the University.

The North Carolina College of Agriculture and Engineering at Raleigh is yearly graduating large numbers of students in the various fields of engineering who are specifically trained for the industries of the State. At Durham, the former Trinity College, now Duke University, has the greatest building program under way of any university in America. Besides the universities and college mentioned above, there are a number of other important colleges within the State, both for men and for women, where excellent training of a more general nature is given.

STUDIES ON THE CHEMICAL AND PHYSICAL QUALITY OF NORTH CAROLINA WATERS

Analytical work to determine the composition of North Carolina's surface waters was first undertaken by the United States Geological Survey more than twenty years ago. With a foresight that has always been characteristic of its work, the Survey undertook rather comprehensive studies of typical streams in all of the states during the years 1906-07. In North Carolina, the Neuse River at Raleigh, the Cape Fear at Wilmington, and the Yadkin (Peedee) River near Peedee, N. C., were selected. Daily samples were collected; combined as 10-day composite samples, and analyzed over a period of a year in each case. These analyses, still considered very valuable, are presented herein.[1] From that time to this, they have remained the most complete analytical chemical studies ever made of North Carolina streams.

Subsequently, it does not seem that any further studies of note were undertaken by a governmental agency until after the creation of the present Water Resources Division of the Department of Conservation and Development in 1921. In 1925, following negotiations initiated by the Division with the Quality of Water Division of the U. S. Geological Survey, a co-operative program of work was undertaken. By the terms of this agreement the Water Resources Division of the Department of Conservation and Development and the District Office of the U. S. Geological Survey at Asheville, agreed to have their personnel collect samples of water as they traveled in connection with their other activities; and the Quality of Water Division of the U. S. Geological Survey in Washington agreed to undertake their analysis as its laboratory facilities and other work would permit without cost to the State other than express on the shipment of samples. It was assumed at that time that the results would be published by the Survey.

Proceeding on that basis, approximately sixty samples were analyzed during the years 1925-26, and the results of these determinations are presented herein; some of them for the first time. However, there was an unsatisfactory limit to the number of samples that could be handled, and the unavoidable delay

[1]Originally presented in U. S. Geological Survey Water Supply Paper 496: The Quality of Surface Waters in the United States, Part I, 1909.

in rendering reports was often the cause of embarassment when the need for the information was urgent.

The increasing frequency with which urgent requests came into the Department for information relative to the quality of the water in almost every section of the State, caused Director Wade H. Phillips to take note of the situation early in 1927. Director Phillips effected an agreement with E. E. Randolph, Professor of Chemical Engineering, State College of Agriculture and Engineering, Raleigh, N. C., whereby Dr. Randolph agreed to devote his time during the summer of 1927 to analytical work in connection with Water Analyses, and to aid the Water Resources Division in the preparation of a report during the following fall. Unfortunately, construction on the State College campus forced Dr. Randolph to work in an improvised laboratory, but too much cannot be said of the diligence and devotion of his application. This work during the summer provided seventy analyses, which, when added to a number previously analyzed by Dr. Randolph, increased the analyses in the fiiles of the Department by about ninety.

ACKNOWLEDGMENTS

So many persons have been concerned directly and co-operatively with the work, that personal mention and credit can not be given except in a few instances. Permission to publish the U. S. Geological Survey analyses was extended to the Department by the director, George Otis Smith, whose permission was secured through the kind assistance of N. C. Grover, Chief Hydraulic Engineer, and W. D. Collins, Chief Chemist of the Water Resources Division of the Survey. Acknowledgment to them would not be complete without mentioning the name of Miss Margaret D. Foster, analyst in the U. S. Geological Survey Laboratory, who was most intimately associated with each and every analysis except those made in the years 1906-07. The July, 1927, number of "Industrial and Engineering Chemistry" published an article of interest, "Surface Waters of Western North Carolina," written by Miss Foster.[1]

E. E. Randolph, Professor of Chemical Engineering, State College, Raleigh, N. C., besides being the analyst reporting approx-

[1]The Water Resources Division of the Department at Chapel Hill, N. C., has a limited number of reprints of this article on hand at the time of the printing of this report. Copies will be furnished on request.

imately 90 of the analyses, as will be noted in the tables, has collaborated in the preparation of parts of the report.

The Development Service of the Southern Railway System, through J. C. Williams, manager, has contributed a number of analyses as reported by their J. C. Ramage, Engineer of Tests, Norfolk, Virginia.

Chambers of commerce have cooperated in the collection of samples, and have supplied a number of miscellaneous analyses. The same should be said of various superintendents of water works and their employees. Sufficient room was not available in the tables to allow us to state the name of the person collecting the individual samples, and thanks are here given to those persons who have aided us in that way. However, it may be said that Thorndike Saville, E. D. Burchard,[2] and Charles E. Ray, Jr., each personally collected a large number of the samples, particularly those from undeveloped sources. The data has been compiled and the report has been assembled by the Department's Water Resources Division which is located in the Engineering School building of the University of North Carolina at Chapel Hill.

The various activities leading to the compilation and preparation of the report have been handled largely by an assistant engineer with the division, Charles E. Ray, Jr., under the supervision of Thorndike Saville, Chief Hydraulic Engineer of the Department of Conservation and Development, and Professor of Hydraulic and Sanitary Engineering in the School of Engineering, University of North Carolina. Credit is also due to Miss Eliza Moore of the secretarial staff of the division for her help in copying and checking the analyses during the process of compilation and assembling.

Plate I was prepared by G. Wallace Smith, Assistant Professor of Engineering in the Engineering School of the University of North Carolina; the compiling of the data represented thereon having been handled by a number of persons. The preparation of the data from which the temperature and rainfall lines were plotted was handled under the supervision of Mr. Saville by F. M. Bell, who holds a graduate fellowship in the Engineering School of the University and is a part time research assistant

[2]District Engineer, United States Geological Survey, Asheville, N. C.

with the division. The stream gaging station locations as given in the table were checked in the district office of the U. S. Geological Survey under the direction of Mr. E. D. Burchard, District Engineer.

Plate II was prepared by R. M. Trimble, Assistant Professor of Engineering in the University Engineering School, from data collected by the division.

The analyses furnished by the Southern Railway System, originally reported in the combined form in terms of grains per gallon, were restated by J. C. Ramage in the radicle form in terms of parts per million at the request of the Water Resources Division.

PART II

NORTH CAROLINA SURFACE WATER RESOURCES GENERAL

Location and Extent.—"The State of North Carolina is situated on the Atlantic seaboard between 33° 50′ and 36° 33′ north latitude and between 75° 27′ and 84° 26′ west longitude, this having a total width from north to south of nearly 200 miles and from east to west of over 500 miles. Its eastern and western boundaries conform largely to the great natural confines of sea and mountains, the former with its curving shore line being more than 300 miles in length, while the latter trends northeast to southwest along the crest of the Appalachian Mountain system for over 200 miles. The northern and southern boundaries, on the other hand, are mainly conventional lines, the former a (nearly) due east and west line about 325 miles in length and the southern a broken line about 375 miles in length. The total area of the State is 52,286 square miles, of which 3,620 square miles are water."[1]

Being located as it is with its greatest length running almost due east and west, and with the greater part of its area lying between the 35th and 37th degrees of north latitude, there are no marked differences in the climatic conditions in the various sections of the State except those attendant upon topographic features. In addition, the climate of parts of the eastern shore of the State is influenced by the path of the Gulf Stream.

CLIMATIC CONDITIONS EXISTING IN NORTH CAROLINA

This report is not a treatise on the climatic conditions of North Carolina[1] and space will be taken only to describe the climate of the State in a general way with particular reference to the precipitation occurring and its relation to the resulting water resources.

Mention has previously been made of the effect of topographic features as affecting local climatic conditions. Starting with zero elevation at the coast line, the profile of the State taken along a line running due west and passing through the crest of

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[1]William Bullock Clark, in "The Coastal Plain of North Carolina." Vol. III, The North Carolina Geological and Economic Survey, 1912.

[1]The Water Resources Division has in preparation a Bulletin on the Climate of North Carolina which will present detailed data and charts illustrating the variations in rainfall, temperature, humidity and frost as they affect the climate of the State.

Mount Mitchell, would show a continuously, though irregular, increasing slope until the maximum elevation of 6,711 feet was obtained at Mount Mitchell, after which it would descend to an elevation of approximately 1500 feet at the North Carolina-Tennessee state line. The increasing elevations very naturally affect both mean annual temperature and mean annual precipitation. Within a given latitudinal zone, the temperature ordinarily will vary inversely with the altitude in any given season. The precipitation is not so closely related to altitude as such, but mountains, because of their effect upon air currents tend to rob the winds of their moisture content, and hence the windward side of the mountains will in general have a higher precipitation than will be found on the slopes of the leeward side, and over the flats beyond.

As an illustration of the variation in the mean annual rainfall with altitude in North Carolina a chart is presented (Figure 1) on which the profile of the State taken along the parallel of latitude, 36° N. has been plotted, together with a curve indicating the mean annual rainfall occurring over the regions traversed by the profile. This chart, originally prepared several years ago by Roy J. Morton, while a graduate student[1] in the Engineering School of the State University, has been checked recently in the light of more extended records, and it is approximately correct. However, as the rainfall records referred to are of varying length and as it has been necessary to sketch the curve in between points representing the rather widely separated U. S. Weather Bureau Station, it should be considered chiefly as an illustration.

All climatological tables have been omitted from this report and the data in a summarized form is presented on Plate I, to which attention is directed. On this plate, mean annual temperatures, as indicated by the records of the U. S. Weather Bureau, are shown by the curvilinear lines of the red overprint. The mean annual precipitation in its distribution over the State is portrayed in the brown overprint. Because of lack of Weather Bureau stations in some localities, and because of the shortness of the records at some of the established stations, it may be found that to a slight degree in some sections, the representa-

[1]Now Principal Assistant Engineer with the Tennessee State Board of Health.

tions of Plate I regarding temperatures and precipitation are slightly in error, but the available records are of sufficient comprehensiveness to enable the Department of Conservation and Development to present Plate I with a high degree of confidence.

Attention is called to the fact that the mean annual temperature in North Carolina varies in different parts of the State from 50 to 63 degrees Fahrenheit. In the extreme northwestern part of the State there is a narrow zone in the vicinity of Boone having a mean annual temperature of between 50 and 51 degrees Fahrenheit. In the extreme southeastern part of the State in the vicinity of Wilmington, a narrow zone is found having a mean annual temperature of approximately 63 degrees Fahrenheit. In all other sections of the State, it will be found that the mean temperatures are intermediate, and a study of the map will show that the greater part of the State has a mean annual temperature of between 55 and 60 degrees Fahrenheit.

PRECIPITATION

In this respect North Carolina can complain but little, because in the ordinary year the rainfall in its distribution and amount is so satisfactory that weather prophets are rare, and the science of meteorology too much neglected. Moreover, floods of serious magnitude, comparatively speaking, are practically unknown, and serious droughts resulting from deficient precipitation are extremely infrequent occurences. Detailed data cannot be given in this report as to seasonal distribution of precipitation or as to its annual variations as shown by the long records. However, the brown overprint of Plate I has been prepared to show the mean annual precipitation occurring in the various localities of the State. The information here presented has been prepared from a detailed consideration of the records of the United States Weather Bureau. Over the greater part of the State, the mean annual precipitation is between 45 and 55 inches with an average of about 50 inches. The figures just given apply particularly to the Piedmont and Coastal Plain sections. In the Mountain Section, a situation of rather striking contrast exists. Considered as a whole it has the greatest precipitation of any section of the State, and the run-off is correspondingly large. In the vicinity of Highlands, a most delightful resort section,

FIGURE 1

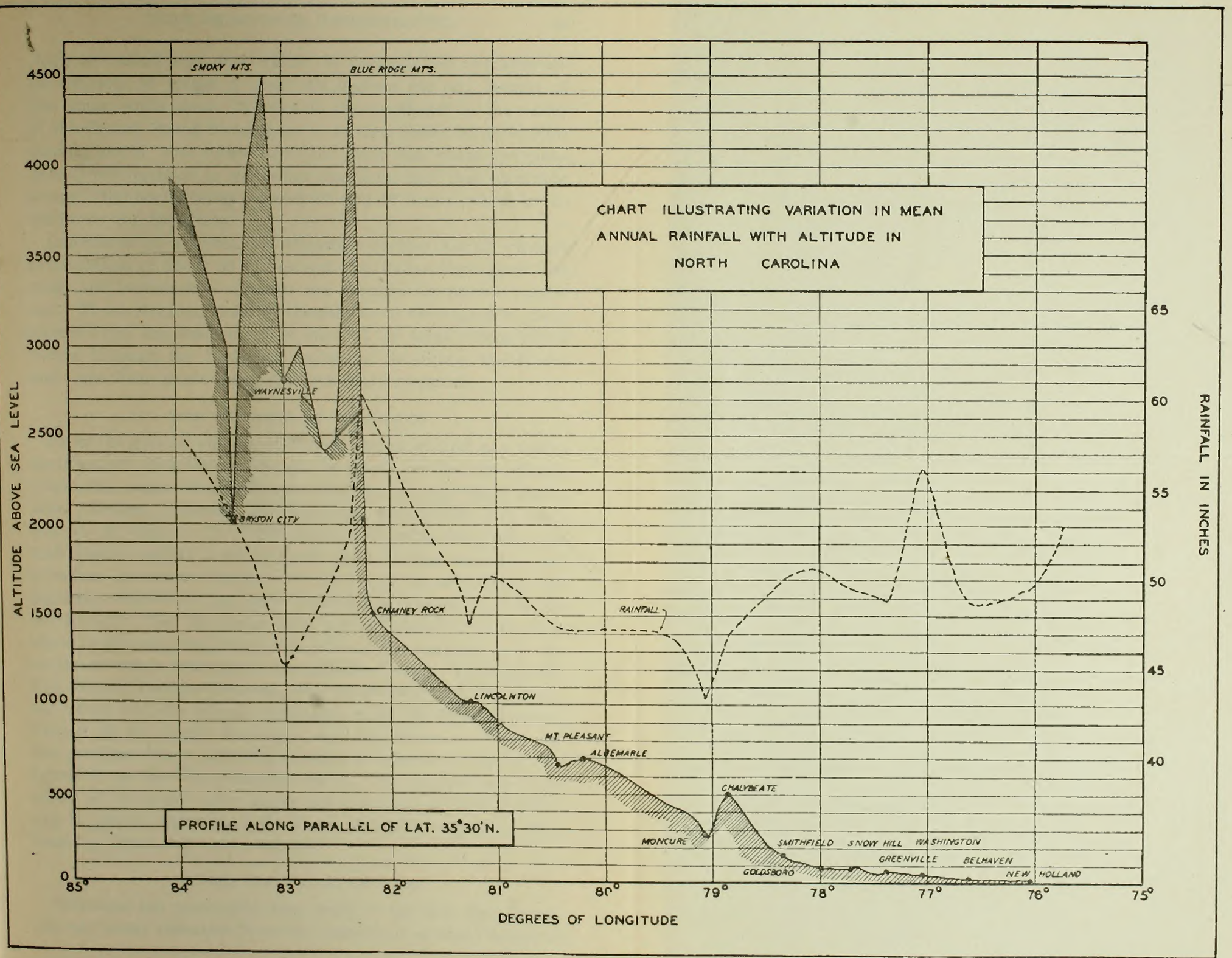
CHART ILLUSTRATING VARIATION IN MEAN ANNUAL RAINFALL WITH ALTITUDE IN NORTH CAROLINA
SMOKY MTS.
BLUE RIDGE MTS.
WAYNESVILLE
BRYSON CITY
CHIMNEY ROCK
LINCOLNTON
MT. PLEASANT
ALBEMARLE
CHALYBEATE
MONCURE
SMITHFIELD
SNOW HILL
WASHINGTON
GREENVILLE
BELHAVEN
GOLDSBORO
NEW HOLLAND
RAINFALL
PROFILE ALONG PARALLEL OF LAT. 35°30'N.
ALTITUDE ABOVE SEA LEVEL
RAINFALL IN INCHES
DEGREES OF LONGITUDE
0
500
1000
1500
2000
2500
3000
3500
4000
4500
40
45
50
55
60
65
85°
84°
83°
82°
81°
80°
79°
78°
77°
76°
75°

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there is a small area over which the precipitation averages approximately 80 inches a year, the highest for any section of the State, while about 75 miles to the northeast in the valley of the French Broad River there is an area about 20 miles wide running north from Asheville to the State line where the mean annual precipitation is somewhat less than half that occurring around Highlands, being between 35 and 40 inches which is the minimum for the State.

Considered as a whole, the Mountain Section has an average precipitation of about 60 inches well distributed throughout the year, and innumerable streams are required to provide drainage. These streams, small in themselves in the region of their source, from the headwaters of most of the large rivers which course through the Piedmont region of the State, the Neuse and Cape Fear rivers being the principal exceptions.

THE DRAINAGE OF THE STATE

From the general vicinity of Tuxedo and extending in a north-northeasterly direction, a line can be drawn on the map to represent the divide which will pass through, or near Black Mountain, Newland, Altapass, Blowing Rock, and thence in a more easterly direction to the North Carolina-Virginia state line. On both Plates I and II it will be found that this has been done and attention is invited thereto. To the west of this divide, the drainage, insofar as the main streams are concerned, is to the northwest to the Tennessee river and ultimately to the Ohio, while to the east the general direction of the drainage is to the southeast and is tributary to the Atlantic Ocean. The Roanoke, Tar, Neuse, Yadkin, Catawba, and Broad rivers are the principal streams of the Atlantic drainage; while the New, Watauga, French Broad, Little Tennessee, and the Hiwassee rivers are the principal North Carolina streams in what is commonly referred to as the Ohio Drainage Basin. The approximate boundaries of the main river basins are indicated on both Plates I and II, and in referring to the maps and tables together, these boundary lines will prove helpful.

STREAM DISCHARGE RECORDS

Reference has previously been made to the fact that in considering water resources from the standpoint of their industrial

utilization, both quality and quantity are factors that must be considered. It has not been found advisable to include any information in this report bearing on the quantity factor in any detail, but in Table I the main river basins are taken up in order, and for each basin a tabulation is given of the streams for which discharge records can be obtained. In some instances these records will extend over a period of only a few months while in other instances, and this applies to a large number of the streams listed in Table I, continuous discharge records of several years length are available. In the case of the Yadkin River Station at Salisbury and the French Broad River at Asheville, the records are thirty-two and twenty-four years in length, respectively.

Each gaging station is designated by a number found in the first column of Table 1. The numbers in the second column under the heading, "Bulletin 34 numbers", refer to a system of numbers now abandoned, which was used on Plate I of the Department's Bulletin 34: "Discharge Records of North Carolina Streams, 1889-1923". In the last column of Table 1 under the heading of remarks, the letter "A" has been used to note that the station is active and giving current records, and the letter "D" has been used to note that the station has been discontinued.

All of the discharge data relative to the flow of North Carolina streams during the period of 1889-1923 have been published by the Water Resources Division of the Department as Departmental Bulletin 34.[1] Persons desiring stream flow records from stations bearing a Bulletin 34 number in Table 1 should address a request for a copy of the bulletin to the Department. If continued records are available for any part of the period 1924-to date, blue-print copies of the data will be furnished at cost.

[1]North Carolina Department of Conservation and Development: Bulletin No. 34, Discharge Records of North Carolina Streams, 1889-1923. Because of the rather large expenditure incurred in the preparation and printing of Bulletin 34, the Department has found it necessary to make a charge of $1.50 a copy. It can be obtained by writing to the Department offices either at Raleigh or Chapel Hill.

TABLE 1—Stream Gaging Stations at Which There Is a Record of a Year or More as to the Discharge of North Carolina Streams

Station Number See Map	Bulletin 34(1) Station Number	Stream and Approximate Location of Station (2)	County	Approx. Drainage Area Sq. Mi. Above Station	Remarks: A-Active Station. D-Discontinued Station.
		ROANOKE RIVER BASIN			
101	1	Roanoke River.....Roanoke, Va.....	Roanoke.....	388	A
102	4	Roanoke River.....Neal, N. C.....	Bertie.....	8717	D
103	10	Dan River .....South Boston, Va...	Halifax.....	2820	D
104	2	Roanoke River.....Randolph, Va.....	Charlotte.....	3076	D
105	9	Dan River.. .....Madison, N. C.....	Rockingham.....	605	D
106	3	Roanoke River.....Old Gaston, N. C....	Northampton.....	8350	A
107	5	Dan River.....Pinnacles, Va.....	Patrick.....	35	D
108	8	Dan River.....Pine Hall, N. C.....	Stokes.....	459	D
109	7	Dan River.....George's Mill, Francisco, N. C.....	Stokes.....	.....	A
110	6	Dan River.....Joyce's Mill, Asbury, N. C.....	Stokes.....	.....	D
		TAR RIVER BASIN			
201	11	Tar River.....Tarboro, N. C.....	Edgecombe.....	2100	D
202	12	Fishing Creek..... Brick School, Enfield, N. C.....	Halifax.....	462	U. S. W. B. Stages No daily Discharge
		NEUSE RIVER BASIN			
301	13	Neuse River.....Selma, N. C.....	Johnston.....	1240	D
302	14	Moccasin Creek.....Taylor's Mill, Middlesex, N C.....	Johnston-Nash....	.....	D
303	15	Little Creek.....Zebulon, N. C.....	Wake.....	5.2	D
304	109	Flat River.....Bahama, N. C.....	Durham.....	147	A
305	.....	Rocky Creek.....Bahama, N. C.....	Durham.....	.....	A
306	.....	Dry Creek.....Bahama, N. C.....	Durham.....	.....	A
307	.....	Dial Creek.....Bahama, N. C.....	Durham.....	.....	A
308	.....	Neuse River.....Northside, N. C.....	Durham.....	578	A New Station
309	.....	Neuse River.....Clayton, N. C.....	Johnston.....	1215	A New Station
310	114	Flat River.....Bahama, N. C.....	Durham.....	170	A New Station
311	.....	Eno River.....Hillsboro, N. C.....	Orange.....	.....	A New Station
		CAPE FEAR RIVER BASIN			
401	24	Cape Fear River.....Fayetteville, N. C....	Cumberland.....	4290	D
402	22	Deep River.....Moncure, N. C.....	Chatham.....	1400	D
403	17	Haw River.....Moncure, N. C.....	Chatham.....	1800	D
404	21	Deep River.....Cumnock, N. C.....	Lee.....	1110	D
405	20	Deep River.....Ramseur, N. C.....	Randolph.....	343	A
406	18	Morgans Creek.....Chapel Hill, N. C....	Orange.....	29	A
407	19	West Fork of Deep River near.....High Point, N. C.....	Guilford.....	33	D
408	23	Cape Fear River.....Lillington, N. C.....	Harnett.....	3530	A
409	.....	Reedy Fork Creek.....Nr. Summerville, N.C.	Guilford.....	35	A
410	.....	Horsepen Creek.....Nr. Battle Ground, N. C.....	Guilford.....	15.4	.....
		YADKIN RIVER BASIN			
501	27	Yadkin River.....Salisbury, N. C.....	Rowan.....	3400	D
502	29	Yadkin River.....Norwood, N. C.....	Stanly.....	4614	D
503	25	Yadkin River.....N .Wilkesboro, N.C...	Wilkes.....	500	A
504	30	Yadkin River.....Pee Dee, N. C.....	Anson.....	6830	D

1.(a) Bulletin 34: Discharge Records of North Carolina Streams, 1889-1923; Water Resources Division, North Carolina Department of Conservation and Development, Chapel Hill, N. C.

1.(b) Stations not having Bulletin 34 number, have been established since 1923, but information concerning discharge will gladly be furnished for any listed stream upon request.

2. All stations are maintained in cooperation with the Water Resources Division of the U. S. Geological Survey.

TABLE 1—Continued

Station Number See Map	Bulletin 34(1) Station Number	Stream and Approximate Location of Station (2)	County	Approx. Drainage Area Sq. Mi. Above Station	Remarks A-Active Station. D-Discontinued Station
505	47	Third Creek.....Statesville, N. C.....	Iredell.....	68.9	D
506	26	Yadkin River.....Donnaha, N. C.....	Forsyth.....	1600	D
507	28	Yadkin River.....High Rock, N. C.....	Davidson.....	3930	D
508	32	Ararat River.....Pilot Mountain, N.C..	Surry.....	250	D
509	31	Fisher River.....Dobson, N. C.....	Surry.....	109	A
510	.....	Pee Dee River.....Nr. Rockingham, N.C.	Anson-Richmond	Note 504	A
511	.....	Yadkin River.....Nr. Yadkin College..	Davidson.....	To be established in 1928.	New Station
512	.....	South Yadkin River.....Cooleemee, N. C.....	Davie.....	To be established in 1928.	
		CATAWBA RIVER BASIN			
601	39	Catawba River.....Rock Hill, S. C.....	York.....	2987	D
602	38	Catawba River.....Catawba, N. C.....	Catawba.....	1535	D
603	44	Johns River.....Morganton, N. C.....	Burke.....	213	D
604	43	Linville River .....Bridgewater, N. C....	Burke	86	D
605	36	Catawba River.....Morganton, N. C.....	Burke.....	758	D
606	42	Linville River.....Fonta Flora, N. C....	Burke.....	67	D
607	35	Catawba River. .....Old Fort, N. C	McDowell.....	14.7	D
608	40	Mill Creek.....Old Fort, N. C.....	McDowell.....	21.2	D
609	45	Johns River.....Collettsville, N. C....	Caldwell.....	69	D
610	34	Santee River.....Ferguson, S. C.....	Orangeburg.....	14800	.....
611	37	Catawba River.....Rhodhiss, N. C.....	Caldwell.....	1180	D
612	48	Wilson Creek.....Adako, N. C.....	Caldwell.....	66	D
613	41	Linville River.....Branch, N. C.....	Burke.....	65	A
614	46	Little Sugar Creek near..Charlotte, N. C.....	Mecklenburg.....	41.4	A
615	115	Henry Fork.....Henry River, N. C...	Burke.....	80	A
		BROAD RIVER BASIN			
701	51	Second Broad River.....Logan's Store, N. C...	Rutherford.....	98	D
702	50	Green River.....Saluda, N. C.....	Henderson.....	51	D
703	49	Broad River.....Uree, N. C.....	Rutherford.....	100	D
704	52	North Pacolet River.....Tryon, N. C.....	Polk.....	49	D
705	111	Sandy Run.....Boiling Springs, N. C.	Cleveland.....	67	A
706	112	Second Broad River.....Cliffside, N. C.....	Rutherford.....	230	A
707	113	Broad River.....Boiling Springs, N. C	Cleveland.....	815	A
708	116	Saluda River.....Columbia, S. C.....	Richland.....	2450	A
709	.....	Broad River.....Lake Lure, N. C.....	Rutherford.....	.....	A
		SAVANNAH RIVER BASIN			
801	110	Tugaloo River.....Hartwell, Ga.....	Hart.....	905	.....
		NEW RIVER BASIN			
901	55	New River, South Fork..Crumpler, N. C.....	Ashe.....	325	D
902	54	New River, North Fork..Crumpler, N. C.....	Ashe.....	279	D
903	53	New River, North Fork..Warrensville, N. C...	Ashe.....	113	D
904	56	New River, South Fork..Jefferson, N. C.....	Ashe.....	207	D
905	118	New River, South Fork..Bowie, N. C.....	Ashe.....	.....	D
		WATAUGA RIVER BASIN			
1001	59	Watauga River.....Butler, Tenn.....	Johnson.....	427	.....
1002	60	Watauga River.....Elizabethton, Tenn...	Carter.....	408	D
1003	61	Doe River.....Valley Forge, Tenn...	Carter.....	132	A
		FRENCH BROAD RIVER BASIN			
1101	69	French Broad River.....Asheville, N. C.....	Buncombe.....	949	A
1102	84	Pigeon River.....Newport, Tenn.....	Cocke.....	655	.....
1103	70	French Broad River.....Old Town, Newport, Tenn.....	Cocke.....	1860	.....
1104	63	Nolichucky River.....Greenville, Tenn.....	Greene.....	1100	D
1105	76	Mills River, North Fork..Pinkbed, N. C.....	Henderson.....	24	D
1106	75	Mills River, South Fork..Sitton, N. C.....	Henderson.....	40.5	D
1107	72	Davidson River.....Davidson River, N. C.	Transylvania.....	31	D
1108	68	French Broad River.....Horsehsoe, N. C.....	Henderson.....	325	D

TABLE 1—Continued

Station Number See Map	Bulletin 34(1) Station Number	Stream and Approximate Location of Station (2)	County	Approx. Drainage Area Sq. Mi. Above Station	Remarks: A-Active Station. D-Discontinued Station.
1109	74	Little River.....Calhoun, N. C.....	Transylvania.....	59	D
1110	65	French Broad River.....Rosman, N. C.....	Transylvania.....	66	D
1111	78	Mud Creek.....Naples, N. C.....	Henderson.....	112	D
1112	82	Pigeon River.....Canton, N. C.....	Haywood.....	134	D
1113	81	Ivy River.....Democrat, N. C.....	Buncombe.....	164	D
1114	.....	Swannanoa River.....Swannanoa, N. C.....	Buncombe.....	60	A
1115	64	North Toe River.....Spruce Pine, N. C....	Mitchell.....	130	D
1116	71	French Broad River.....Dandridge, Tenn.....	Jefferson.....	4450	.....
1117	62	Nolichucky River.....Embreeville, Tenn....	Washington.....	795	.....
1118	85	Little Pigeon River.....Sevierville, Tenn.....	Sevier.....	346	.....
1119	80	Swannanoa River.....Biltmore, N. C.....	Buncombe.....	128	D
1120	73	Davidson River.....Brevard, N. C.....	Transylvania.....	41	A
1121	67	French Broad River.....Blantyre, N. C.....	Transylvania.....	296	A
1122	83	Pigeon River.....Crabtree, N. C.....	Haywood.....	244	A
1123	120	Pigeon River.....Mt. Sterling, N. C....	Haywood.....	453	A
1124	77	Mills River.....Mills River, N. C....	Henderson.....	67.5	D
1125	66	French Broad River.....Calvert, N. C.....	Transylvania.....	104	A
1126	.....	North Fork, Swannanoa River..... Nr. Blk. Mountain, N, C.....	Buncombe.....	22	A
1127	.....	Bee Tree Creek.....Swannanoa, N. C.....	Buncombe.....	5.7	A
1128	.....	South Fork, Mills River..Pinkbeds, Pisgah Nat. Forest, N. C.....	Henderson.....	9.87	A
1129	.....	Pigeon River... .....Hepco, N, C.....	Haywood.....	.....	A
		LITTLE TENNESSEE RIVER BASIN			
1201	88	Little Tennessee River...Judson, N. C.....	Swain.....	668	A
1202	94	Tuckaseegee.....Bryson, N. C.....	Swain.....	673	A
1203	90	Little Tennessee River...McGhee, Tenn	Monroe.....	2470	A
1204	96	Nantahala River.....Nantahala, N. C.....	Swain.....	144	D
1205	93	Tuckaseegee River.....East Laport, N.C....	Jackson.....	200	D
1206	86	Little Tennessee River...Franklin, N. C	Macon.....	297	D
1207	91	Cullasaja Creek.....Cullasaja, N. C.	Macon.....	87	A
1208	99	Cheoah River .....Millsaps, N. C.....	Graham	.....	D
1209	95	Scott's Creek.....Dillsboro, N. C.....	Jackson.....	.....	D
1210	89	Little Tennessee River...Calderwood, Tenn ...	Blount.....	1870	A
1211	98	Nantahala River.....Almond, N. C.....	Swain.....	177	A
1212	87	Little Tennessee River...Almond, N. C.....	Swain.....	453	D
1213	100	Cheoah River .....Johnson, N. C.....	Graham	175	A
1214	97	Nantahala River.....Wesser, N. C.	Swain.....	160	D
1215	92	Oconalufty River .....Cherokee, N. C.....	Swain.....	133	A
1216	.....	Little Tennessee River...Etna, N. C.....	Macon.....	.....	A
1217	.....	Cullasagee Creek.....Highlands, N. C.....	Macon.....	.....	New Station
		HIWASSEE RIVER BASIN			
1301	102	Hiwassee River.....Murphy, N. C.....	Cherokee.....	410	A
1302	104	Hiwassee River.....Reliance, Tenn.....	Polk.....	1180	A
1303	108	Nottely River.....Ranger, N. C.....	Cherokee.....	272	A
1304	107	Valley River.....Tomotla, N. C.....	Cherokee.....	106	A
1305	101	Hiwassee River.....Hayesville, N. C.....	Clay.....	190	D
1306	106	Tusquitee River.....Hayesville, N. C.....	Clay.....	40	D
1307	103	Hiwassee River.....Apalachia, Tenn.....	Polk.....	1042	D
1308	105	Shooting Creek.....Hayesville, N. C.....	Clay.....	37.9	D

PART III.

CHEMICAL QUALITY OF THE SURFACE WATERS OF NORTH CAROLINA BY PHYSIOGRAPHIC SECTIONS

The Department herewith presents the chemical analyses which it has been able to assemble from all sources. Totaling 185 in number, 174 are analyses of samples from surface sources and 11 refer to samples from underground sources. Primarily, this report pertains to surface water supplies; no attempt being made to present information relative to our valuable underground water resources of the Coastal Plain Section, other than a few analyses, though the Department thoroughly appreciates their importance and value as sources of both domestic and industrial supplies, and has requested appropriations for their investigation.

The fundamental analytical data on the chemical and physical quality of the waters described in this bulletin are presented in the following tables:

Table 2. Analyses of Surface Waters in Mountain Section of North Carolina.
Table 4. Analyses of Surface Waters in the Piedmont Section of North Carolina.
Table 5. Analyses of Water from Neuse river at Raleigh, N. C., Oct. 1, 1906-Oct. 1, 1907.
Table 6. Analyses of Water from Dan River at South Boston, Va., Sept. 3, 1906-May 2, 1907.
Table 8. Analyses of Waters in the Coastal Plain Section of North Carolina.
Table 9. Analyses of Waters from Peedee (Yadkin) River near Peedee, N. C., Oct. 26, 1906-Oct. 19, 1907.
Table 10. Analyses of Water from Roanoke River at Randolph, Va., Sept. 7, 1906-May 12, 1907.
Table 11. Analyses of Water from Cape Fear River at Wilmington, N. C.
Table 13. Analyses of Surface Waters of North Carolina as Reported by the Development Service of the Southern Railway.
Table 14. Analyses of Surface Waters of North Carolina as Reported from Different Laboratories (a Miscellaneous group).

In tabulating the analyses, because of convenience and various other reasons, they have been grouped according to the physiographic sections of the State containing the streams to which the individual analyses severally refer. The physiographic sections

considered herein are the Mountain section, the Piedmont Plateau section, and the Coastal Plain section. Besides presenting the analyses by "sections", a concise description is given of the physical features of each section. The descriptive matter is given for the benefit of those who are not particularly familiar with the State and are not, therefore, in a position to properly visualize North Carolina in relation to her water resources.

Before considering these data by sections, a general statement will be made relative to the samples as collected, and the analyses as reported. Insofar as the samples reported on by the U. S. Geological Survey and Dr. E. E. Randolph are concerned, most of them were collected either by engineers associated with the work or by water works superintendents. The standard one gallon bottle and container of the U. S. G. S. type was used. No information is at hand as to the method of collection of the other samples.

A report of each analysis has been made to the Department in the case of analyses by the U. S. Geological Survey and Dr. Randolph on the form reproduced in Figure 2. It will be noticed that provision has been made on this form for information other than that which has been included in the tables; viz: capacity of filter plant, drainage areas, stage, etc., and in a good many cases some of this information is available in the files of the Water Resources Division, Chapel Hill, N. C. On request, all available information will be supplied relative to any particular analysis or to the stream to which it refers. In referring to an analysis, the "Water Resources Number" should be used and the name of the stream together with the statement of the sampling point should be given. This information will be found in columns 1 and 2 of each of the main tables. "Water Resources Numbers" in the number region 100-399 refer to analyses of waters in the Mountain section; 400-799 to waters in the Piedmont section; 800-999, to surface waters in the Coastal Plain Section; and 1000 and over, to underground waters.

FIGURE 2

REPORT OF MINERAL ANALYSIS

DEPARTMENT OF CONSERVATION AND DEVELOPMENT
WATER RESOURCES DIVISION, CHAPEL HILL, N. C.

Water Resources No..... Laboratory Number.....
Stream: .....
Point Sampled: .....
..... County: .....
Stage of Stream:..... Rate of Flow: .....
Drainage area above point of collection, or intake: .....
Capacity of..... plant, millions of gallons per 24 hours.....
Remarks: .....
Collection by: ..... Date:.....
Analysis by: ..... Date:.....

	Parts Per Million
Silica (SiO_2)	
Alumina (Al_2O_3)	
Iron (Fe)	
Calcium (Ca)	
Magnesium (Mg)	
Sodium (Na)	
Potassium (K)	
Carbonate radicle (CO_3)	
Bicarbonate radicle (HCO_3)	
Sulphate radicle (SO_4)	
Chloride radicle (Cl)	
Nitrate radicle (NO_3)	
.....	
Total dissolved solids at	
Total hardness as $CaCO_3$ (calc.)	
Color	
Turbidity	
Suspended matter	
Alkalinity	
pH	
.....	

Remarks:

METHODS OF ANALYSIS

The analyses of the U. S. Geological Survey were made by the methods regularly used for the analyses of water in the U. S. Geological Survey, which are essentially the same as those recommended by the American Public Health Association published in 'Standard Methods of Water Analysis'. Dr. E. E. Randolph, a chemist long experienced in water analysis work, spent some time at the laboratory of the Geological Survey in consultation with the chief chemist and others of the staff prior to undertaking the co-operative work with the Department during the summer, and his practice was identical with that of the United States Geological Survey. A more detailed statement as to the methods used will be found in Appendix A.

STREAMS FROM WHICH SAMPLES HAVE BEEN COLLECTED AND ANALYZED

After sectionizing the tables according to geographic location, the same scheme was put into effect in preparing a spot map (Plate II) to facilitate the locating of sampling points on streams for which analyses are given. In the case of each of the analyses, the tables contain the name of the county in which the stream is located, the name of the stream, and the approximate location of the sampling point. Keeping in mind the fact that analyses bearing "Water Resources Numbers" 101-399 are in the Mountain Section; 400-799 in the Piedmont section; and above 799, in the Coastal Plain section, no trouble should be encountered in referring to the map by numbers.

A few of the analyses were received after the map had gone to the printer, and consequently could not be represented on the map. Every effort has been made to indicate the location of sampling points as correctly as possible, but in some cases due to indefinite descriptions and in others due to crowded conditions on the map itself, the location of the circles may be slightly in error. It is believed that they are correctly placed, however, with respect to the stream to which they refer and in their relation to other sampling points on the same stream.

THE MOUNTAIN SECTION

With a heavier average annual precipitation here than in any other section of the State, innumerable small springs nestle on the still forested slopes and serve as the primary source for prac-

tically all of the larger streams which are native to the State. An appreciation of this fact can be gained by examining either Plate I or Plate II and noting the drainage basins which converge in the vicinity of Blowing Rock. In all directions the stream lines follow the slopes indicating the routes of travel for water from the mountains on its way downward to the industrial and domestic populace en route, and below. As a concise description of this North Carolina Highland of incomparable waters, that by Kerr, a former state geologist, relative to its topographic features, will serve admirably:

"The western section is a rugged mountainous plateau; it forms a narrow, irregular, much indented trough, lying between the bifurcating chains of the western and dominant arm of the southern prolongation of the Appalachians—the Smoky mountains and the Blue Ridge—the former being the western boundary of the State. The length of this plateau from northeast to southwest is more than 200 miles, its breadth 15 to 50 miles, and its area nearly 6,000 square miles. The Smoky chain has a general elevation of from 5,000 to 6,000 feet, rising in many summits to 6,500 feet and upwards, but is broken down by half a dozen deepwater gaps or canons to the level of 2,000 and even 1,200 feet. The Blue Ridge, which constitutes the eastern boundary of the plateau, is a very sinuous and angular and straggling mountain chain, with a general elevation of from 3,000 to 4,000 feet and upwards, a few of its higher summits, about midway in the State, reaching nearly 6,000 feet.

"These two bounding chains are connected by many north and south crosschains, of equal elevation with themselves, or greater, and separated by deep valleys. On one of these cross-chains, called the Black Mountains, is Mitchell's Peak, the highest point east of the Mississippi, its altitude being 6,711 feet (400 feet above Mount Washington in New Hampshire). The cross-valleys or river basins have an altitude of from 2,000 to 3,000 feet, with smaller benches and marginal plateaus of from 3,500 to 4,000 feet. Seen from the east or Atlantic side, the Blue Ridge appears as a steep, ragged, and broken escarpment, springing suddenly 2,000 to 3,000 feet above the Piedmont Plateau at its base."

The above description, given with the conciseness characteristic of a geologist, will fail to gain appreciation unless reference is made to Plates I or II, and the topography is traced by noting the outlines of the streams. Noting the line running northeast from Tuxedo through Altapass and Blowing Rock; thence east to the Virginia line, it will be clearly evident that the Blue Ridge is the dominant divide in North Carolina. One

would not suppose that there would be any great difference in the chemical quality of the surface waters on either side of the divide considering only the Mountain section, and such is the case.

Considered as a whole, this region has the highest rainfall of any of the three main sections of the State, and the seasonal variation is extremely satisfactory. The high mean annual rainfall well distributed throughout the year is indicative of the stream flow. There are an endless number of cross-valleys varying in size from small "hollows" to the small river valleys which serve as catchment areas and furnish feeders to the main rivers. The number of streams furnishing from five to ten millions of gallons daily is very large, and there are numerous sources capable of furnishing more water than any single industrial establishment could possibly want. On the western side of the divide, the French Broad River rises in the heights above Rosman and flows across Transylvania County by Brevard, thence across Henderson, Buncombe, and Madison counties receiving the waters of Little, Davidson, Mills, and Swannanoa rivers at their respective points of discharge. Those mentioned are the major tributaries only; there are a great many smaller ones. A little further west there is the Pigeon River with its system of tributaries, while still further west, the network of streams making up the upper Little Tennessee River are to be found. In the extreme southwest, the Hiwassee River originates in Georgia and flows across the State in a westerly direction through Murphy in Cherokee County, receiving on its way the beautiful Valley River which rises above Andrews, and the Nottely River which flows in from the west. In the northwest the New River rises in Ashe and Watauga counties and flows northward into Virginia, and the Watauga River in the county of the same name flows westward into Tennessee.

On the eastern side of the divide, the headwaters of the Broad, the Catawba, and the Yadkin rivers are found. These rivers flow in a generally southeastward direction onto the Piedmont and Coastal Plain sections.

The waters of this Mountain section are of exceptional character. Clear and sparkling in appearance, the turbidity is low, ranging around an average figure of about 30 parts per mil-

lion. The suspended matter averages about 11 parts per million and the color will be found to be around 14 parts per million. The chemical constituents of the waters of the various streams can be determined by reference to the data of Table 2. The iron, calcium, magnesium, sulphates, etc., are extremely low and the total dissolved solids range around an average of 30 parts per million. Table 3 presents an average analysis of western North Carolina waters, and it will be apparent that it compares most favorably with analyses of waters from other states shown in Table 15. The hardness, turbidity, and dissolved solids are unusually low.

With many other natural and man-made advantages in addition to excellent and abundant supplies of water, it is to be expected that industry would be greatly diversified in this region, and such is the case. Industries manufacturing almost every kind and class of goods are to be found, and in the location of a great many of them, the quality of the water available has been a deciding factor.

One of the largest paper mills in the United States is located at Canton, and it uses a tremendous quantity of Pigeon River water. Thirty miles to the west on the Murphy branch of the Southern Railway System a second pulp mill is now being erected. Just outside of Asheville, the Sayles-Biltmore Bleachery, having a capacity of 1,000,000 yards of cloth weekly, is located adjacent to the Swannanoa river. The site for a second bleachery has been purchased near Old Fort. At Rosman, Brevard, North Wilkesboro, Asheville, Hazlewood, Sylva, and Andrews, tanneries are located. Plants producing various grades of textiles are scattered over the entire area. Mention of these particular industries has been made only because they are all users of large quantities of water and have rigid requirements as to its quality. There are many other industries having particular requirements as to water which are not mentioned here.

The analyses of the samples collected from the streams in this section, eighty-one in number, will be found in Table 2. In those cases where the description found in the table proves inadequate, the suggestion is offered that reference be made to Plate II where it will be found that each sampling point has been indicated and identified by means of the "Water Resources Numbers," found in column one of Table 2.

TABLE 2—Analyses of Surface Waters In
(U. S. G. S. Analyses by M. D.

Water Resources Number	NAME OF STREAM AND APPROXIMATE LOCATION OF SAMPLING POINT	County	Date of Collection	Suspended matter	Total dis'd solids	Silica (SiO_2)	Iron (Fe)
			Analyses in parts per million.				
101	Hiwassee River, at U. S. Gaging Sta. in town of Murphy	Cherokee	Aug. 28, 1927	25	37.6	13.2	0.15
102	Collett's Creek, near Andrews-Tributary to Valley River	Cherokee	Aug. 29, 1927	2.5	29.9	8.0	0.18
103	Valley River, above mouth of Colletts Creek	Cherokee	Aug. 29, 1927	25	37.5	11.5	0.25
104	Nottely River, just above mouth of Crane Creek near Murphy	Cherokee	Aug. 28, 1927	30	39.8	9.4	0.2
105	Hanging Dog Creek, above mill dam near Murphy-Tributary to Hiwassee River	Cherokee	Aug 28, 1927	13	45	8.0	0.24
106	Cullasagee River, below Hydro-Electric plant near Highlands	Macon	Aug. 29, 1927	10	32.8	10.5	0.4
107	Lake Emory, on Little Tennessee River near Franklin	Macon	Aug. 20, 1927	8.0	29.3	8.5	0.2
108	Nantahala River, near town of Wesser	Macon	Aug. 26, 1927	12	26.9	9.5	0.25
109	Cheoah River, 1 mile above mouth at Tapoco, N. C	Graham	Apr. —, 1924	10	16	5.3	0.2
110	Scott's Creek, 1 mile above Beta; 3½ miles above Sylva Tannery	Jackson	Aug. 15, 1927	14	39.2	6.7	0.3
111	Oconalufty River, near Bryson City	Swain	Aug. 25, 1927	9	22.5	7.4	0.1
112	Tuckasagee River, 1 mile above Bryson City	Swain	.....	24	31.3	4.7	0.1
113	Yalaka Creek, below 2nd Bridge Highway No. 10 near Patterson Springs	Swain	Aug. 29, 1927	18	23.1	8.0	0.25
114	Hazle Creek, 800 ft. from mouth of Creek Fontana, N. C	Swain	Oct. 31, 1924	0.9	18	6.8	0.11
115	Hazle Creek, at mouth, Fontana, N. C	Swain	Apr. —, 1924	6.3	17	5.2	0.16
116	Eagle Creek, at mouth, Fontana, N. C	Swain	Apr. —, 1924	2.4	16	5.0	0.08
117	Eagle Creek, 100 yds. above mouth, Fontana, N. C	Swain	Oct. 31, 1924	0.5	17	6.8	0.09
118	Little Tennessee River, 700 ft. upstream from the confluence with Cheoah Creek	Graham	Oct. 31, 1924	2.0	25	10	0.21
119	Little Tennessee River, just above mouth of Hazle Creek, Fontana, N. C	Swain	Apr. —, 1924	7.1	20	6.9	0.25
120	Little Tennessee River, 1 mi. below mouth of Eagle Creek, Fontana, N. C	Swain	Apr. —, 1924	4.8	18	6.0	0.20
121	Little Tennessee River, at bend above effluent of Hazle Creek	Swain	Oct. 31, 1924	2.0	26	11	0.18
122	Little Tennessee River, at Cheoah Dam near Tapoco, N. C	Graham	Apr. —, 1924	8.1	23	8.1	0.41
123	Little Tennessee River, 1 mi. down stream from Fontana, N. C. at 6:15 P. M	Swain	Oct. 31, 1924	15	24	8.8	0.49
124	Winchester Creek, near Balsam where it is crossed by Route No. 10	Haywood	Aug. —, 1927	14	36.9	8.0	0.16
125	Waynesville Filtered Water	Haywood	Aug. —, 1927	2	29.7	12.1	0.2
126	Richland Creek, below Lake Junaluska, near Waynesville, N. C	Haywood	June 30, 1927	11	28.95	3.3	0.1
127	Pigeon River, just below the forks of the river at Woodrow, N. C	Haywood	Aug. —, 1927	15	47.8	13	0.4
128	Hendersonville City Water, Tap-Residence of D. M. Wells	Henderson	Sept. 30, 1927	2	23.3	8.5	0.1
129	Mills River, near Mills River, N. C., at gaging station	Henderson	Sept. 30, 1925	5	29	12	0.19
130	Mills River, near gaging station at Mills River, N. C	Henderson	Feb. 6, 1925	1.6	15	6.5	0.13
131	Cane Creek, Fletcher	Henderson	June 20, 1927	16	32.72	8.2	0.4
132	Cane Creek, near Fletcher, N. C., on highway from Hendersonville to Asheville	Henderson	Feb. 6, 1925	7.5	33	13	0.33
133	Davidson River, 2 miles above Pisgah Forest, N. C	Transylvania	Jan. 21, 1925	3.4	21	9.1	0.14
134	Davidson River, gaging station below Pisgah Nat'l Forest Boundary, Brevard	Transylvania	Sept. 30, 1925	.....	22	8.9	0.10
135	Little River, ½mi. above mouth near Davidson River, N. C	Transylvania	Sept. 30, 1925	21	29	11	0.42
136	Impounding Reservoir, Asheville, N. C., mountain str. house tap-city supply	Buncombe	Apr. —, 1922	.....	19	7.8	0.05
137	Flat Creek, just above junction of this creek and another 1 mi. above Black Mt.	Buncombe	Feb. 6, 1925	7	21	8	0.28
138	North Fork, Swannanoa River, gaging sta. proposed Asheville intake	Buncombe	June 9, 1927	18	22.92	8.2	0.2
139	Swannanoa River, North Fork, near Black Mountain, N. C	Buncombe	Feb. 11, 1926	0.5	20	7.4	0.03

The Mountain Section of North Carolina
Foster, Quality of Water Division)

Calcium (Ca_3)	Magnesium (Mg)	Sodium (Na_2)	Potassium (K)	Carbonate radicle (CO_3)	Bicarbonate radicle (HCO_3)	Sulfate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Total Hard'ss Cal'd ($CaCO_3$)	Color	Turbidity	Alkalinity	Authority	Water Resources Number
Analyses in parts per million.														
2.6	0.6	2.5	0.5	0.0	16.5	0.5	0.8	0.2	9	7	40	13	Randolph	101
2.4	0.7	1.9	0.5	0.0	13.0	1.9	1.0	0.3	8.8	7	8	11.0	Randolph	102
3.0	1.2	1.6	0.8	0.0	16.5	1 5	1.0	0.1	12.4	12	45	13.5	Randolph	103
3.4	1.1	2.6	0.6	0.0	18.1	2.0	2.1	0.3	13	15	40	15	Randolph	104
3.5	1.5	3.7	1.4	0.0	20.2	2.3	3.7	0.5	14.9	20	25	16	Randolph	105
2.7	0.7	1.6	0.8	0.0	14.0	0.4	1.5	0.2	9.6	10	15	11.5	Randolph	106
2.3	0.9	1.8	0.6	0.0	12.0	1.8	1.0	0.2	9.4	12	6	10.0	Randolph	107
1.6	0.8	2.0	0.5	0.0	10.0	1.4	0.6	0.2	7.4	25	20	7.5	Randolph	108
1.0	0.6	1.0	0.4	0.0	4.9	1.7	0.3	0.23	5.0	9	.....	.....	U. S. G. S.	109
1.3	2.1	5.0	0.7	0.0	11.0	7.6	5.0	0.2	11.9	10	20	10.5	Randolph	110
1.6	0.8	1.0	0.5	0.0	8.1	2.0	0.7	0.3	7.3	10	12	6.5	Randolph	111
1.0	0.9	5.2	0.8	0.0	11.0	3.6	4.0	1.0	6.2	40	45	10	Randolph	11
2.0	0.5	1.2	0.6	0.0	6.8	1.7	1.6	0.4	7.1	20	30	5.4	Randolph	113
1.4	0.7	1.5	0.4	0.0	6.8	2.2	0.7	0.12	6.4	9	.....	.....	U. S. G. S.	114
1.3	0.6	1.1	0.5	0.0	4.9	2.0	0.4	0.39	5.7	8	.....	.....	U. S. G. S.	115
1.1	0.6	1.0	0.5	0.0	4.9	1.9	0.3	Tr.	5.2	4	.....	.....	U. S. G. S.	116
1.2	0.7	1.1	0.4	0.0	6.	2.1	0.5	0.1	5.9	4	.....	.....	U. S. G. S.	117
2.0	1.0	1.6	0.5	0.0	11	2.0	0.6	0.15	9.1	9	.....	.....	U. S. G. S.	118
1.3	0.8	1.3	0.5	0.0	5.6	2.0	0.5	0.25	6.5	13	.....	.....	U. S. G. S.	119
1.1	0.6	1.2	0.5	0.0	5.9	2.3	0.5	0.19	5.2	9	.....	.....	U. S. G. S.	120
1.8	0.9	1.7	0.6	0.0	11	2.2	1.1	0.10	8.2	13	.....	.....	U. S. G. S.	121
1.4	0.7	1.3	0.6	0.0	6.3	1.9	0.3	0.38	6.4	40	.....	.....	U. S. G. S.	122
1.6	0.9	1.6	0.5	0.0	9.8	2.3	0.7	0.15	7.7	13	.....	.....	U. S. G. S.	123
3.4	1.5	2.0	0.8	0.0	18	1.6	1.0	0.4	15	8	10	21	Randolph	124
1.6	1.1	1.8	0.3	0.0	6.0	3.4	3.0	0.2	8.5	7	10	5	Randolph	125
3.9	0.7	1.9	0.6	0	10.6	3.8	3.5	0.15	12.6	5	12	9	Randolph	126
4.4	2.1	4.3	1.	0	15	3.5	6	0.3	20	10	20	13	Randolph	127
1.4	0.8	1	0.8	0	7.3	1.5	1.3	0.1	6.8	7	6	6.5	Randolph	128
2	0.7	1.3	0.6	0	8.3	2.1	0.7	0.10	7.9	30	15	.....	U. S. G. S.	129
0.6	1	1.3	0.2	0	4.9	2.6	0.6	0.44	5.6	7	2	.....	U. S. G. S.	130
3.8	1	0.7	0.4	1	11.1	2	2.1	0.22	13.6	10	20	9.6	Randolph	131
2.4	1.4	2	0.3	0	13	2.6	1	0.94	12	12	2	.....	U. S. G. S.	132
1.2	1	1.4	0.3	0	7.3	2.6	0.6	0.91	7.1	9	2	.....	U. S. G. S.	133
1.5	0.5	0.9	0.5	0	5.6	1.5	0.4	0.10	5.8	15	10	.....	U. S. G. S.	134
1.6	0.6	1.2	0.5	0	7.1	1.6	0.5	0.10	6.5	40	30	.....	U. S. G. S.	135
0.8	0.6	1.8	0.5	0	7.3	1.7	0.7	Tr.	4	.....	.....	.....	U. S. G. S.	136
1.3	1.2	1.6	0.2	0	6.8	4.1	0.8	0.15	8.2	4	2	.....	U. S. G. S.	137
1.6	0.8	0.8	0.5	0	5.8	1.2	2.7	0.12	7.3	9	20	6.5	Randolph	138
1.5	0.7	0.7	0.4	0	6.1	2.1	0.3	0.27	6.6	8	2.5	.....	U. S. G. S.	139

TABLE 2—

Water Resources Number	NAME OF STREAM AND APPROXIMATE LOCATION OF SAMPLING POINT	County	Date of Collection	Suspended matter	Total dis'd solids	Silica (SiO_2)	Iron (Fe)
			Analyses in parts per million.				
140	Swannanoa River, 4 mi. upstream, Biltmore gaging sta., Asheville, N. C.	Buncombe	Feb. 26, 1925	22	28	11	0.64
141	Swannanoa River, near Biltmore, above Sayles Bleachery, below Recreation Pk.	Buncombe	June 9, 1927	15	23.35	6.2	0.1
142	French Broad River, above Rosman, N. C.	Transylvania	Jan. 21, 1925	6.3	27	15	0.17
143	French Broad River, above Rosman, N. C.	Transylvania	Sept. 30, 1925	18	24	6.5	0.28
144	French Broad River, 2 mi. above mouth Swannanoa River and Hominy Creek	Buncombe	Feb. 6, 1925	8.4	21	8.9	0.25
145	French Broad River, at Long Shoals Bridge, Asheville, N. C.	Buncombe	June 10, 1927	6.5	24.95	7.7	0.15
146	French Broad River, Long Shoals Bridge, mouth of Swannanoa River	Buncombe	Sept. 30, 1925	111	37	12	0.36
147	Broad River, below Chimney Rock, N.C.	Rutherford	Nov. 29, 1925	4.3	37	15	0.06
148	Broad River, 1 mi. below town of Chimney Rock, N. C.	Rutherford	Jan. 27, 1925	7.3	42	22	0.17
149	Second Broad River, U. S. G. S. gaging station, Cliffside, N. C.	Rutherford	Nov. 28, 1925	11	57	16	0.41
150	Green River, ford about 1½ mi. above headwaters Lake Summit near Tuxedo	Henderson	Aug. 30, 1927	15	30.4	9.5	0.15
151	Tryon, N. C. Municipal Supply, tap sample	Polk	July 19, 1927	1	39.6	8	0.05
152	North Pacolet River, Tryon, N. C.	Polk	June 20, 1927	12	34.6	7.6	0.4
153	North Toe River, above Beaver Creek, Spruce Pine, N. C.	Mitchell	Mar. 11, 1925	9.3	31	11	0.52
154	North Fork, Toe River at Spruce Pine, N. C.	Mitchell	Sept. 13, 1925	28	34	8.8	0.18
155	Watauga River, at Cook's Ford near Shulls Mills, N. C.	Watauga	Sept. 14, 1925	2.8	32	9.4	0.22
156	Watauga River, Route No. 69, 8 mi. below Boone, N. C.	Watauga	Apr. 22, 1925	4.5	27	8.8	0.07
157	New River, South Fork, Deep Gap Bridge, 1½ mi. east of Bowie, N. C.	Ashe	Sept. 12, 1925	17	36	10	0.17
158	New River, South Fork near Jefferson, N. C.	Ashe	Sept. 12, 1925	10	28	8.5	0.24
159	New River, South Fork near Jefferson, N.C. gaging sta. highway bridge R.No. 68	Ashe	Apr. 23, 1925	5.8	27	10	0.13
160	New River, North Fork at Warrensville, N. C.	Ashe	Sept. 12, 1925	33	42	12	0.5
161	New River, North Fork, N. Warrensville, N. C., gaging station	Ashe	Apr. —, 1925	7.4	37	13	0.08
162	Elk Creek, below Shoe Factory, just above intake, Elkin water supply	Surry	Nov. 27, 1925	11	34	12	0.30
163	Yadkin River, at N. Wilkesboro, N. C.	Wilkes	Sept. 12, 1925	224	88	12	0.41
164	Yadkin River, U. S. G. S. gaging station, North Wilkesboro, N. C.	Wilkes	Nov. 27, 1925	9.4	50	14	0.40
165	Linville River, U. S. gaging station, Branch N. C.	Burke	Nov. 28, 1925	1.5	27	8.5	0.08
166	Buck Creek, above Lake Tahoma, 8 mi. from Marion, N. C.	McDowell	July 24, 1927	6	39.15	16.8	0.15
167	Catawba River, Highway Bridge, Route No. 10, 2 mi. west of Marion, N. C.	McDowell	Nov. 28, 1927	4.7	37	13	0.17
168	Catawba River, 2 mi. above Marion	McDowell	July 24, 1927	18.9	42.9	3	0.2
169	Henry River, Intake Morganton water supply	Burke	Sept. 12, 1925	3	26	10	0.06
170(a)	Cane Creek, Fletcher, N. C.	Henderson	Aug. 11, 1923	.....	77	31.7	0.45
171	Cathey's Creek, Brevard, N C	.....	Oct. 31, 1925		See table 4.		
172(b)	French Broad River, Horse Shoe, N. C.	Henderson	July 31, 1923	.....	94	22	1.2
173	French Broad River, Marshall, N. C.	.....	.....		See table 4.		
174(c)	Curtis Creek, near Old Fort, N. C.	McDowell	Aug. 11, 1923	.....	76	23	0.5
175(d)	Curtis Creek, Old Fort, N. C.	McDowell	Aug. 11, 1923	.....	77	23.8	0.7
176	Wilson Creek, Mortimer, N. C.	.....	.....		See table 5		
177	Catawba River, Morganton, N. C.	.....	July 25, 1925		See table 4.		
178	Cheoah River, above confluence with Little Tennessee River	Graham	Oct. 31, 1924	2.6	20	8.6	0.14
179	Broad River, Chimney Rock, N. C.	Rutherford	Feb. 9, 1926	10	36	17	0.08
181	Ararat River, near Mt. Airy, N. C.	Surry	Apr. 12, 1926	20	53	10.4	0.25
182	Swift Creek, near Mt. Airy, N. C.	Surry	Apr. 12, 1926	6.0	40	9.7	0.18
183	Lovill's Creek, supply of Mt. Airy, N. C.	Surry	Apr. 12, 1926	2.0	45	11.5	0.21

(a) Inorganic solids, 42; organic solids, 35; color determination made on filtered water; alkalinity reported as calcium carbonate; analyst unknown.

(b) Inorganic solids, 32; organic solids, 62; color determination made on filtered water; alkalinity reported as calcium carbonate; analyst unknown.

(c) Inorganic solids, 40; organic solids, 30; color determinations made on filtered water; stage of stream, normal summer.

(d) Inorganic solids, 38; organic solids, 39; color determinations made on filtered water; sample collected at same point as for W. R. No. 174, but following rain. Analyses 170, 172, 174, and 175 appear to have been reported by the same analyst, but his name is not known to the compiler.

Continued

Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate radicle (CO_3)	Bicarbonate radicle (HCO_3)	Sulfate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Total Hard'ss Cal'd ($CaCO_3$)	Color	Turbidity	Alkalinity	Authority	Water Resources Number
Analyses in parts per million														
1.6	1.4	2	0.3	0	8.8	3.5	1	0.27	9.7	9	50	.....	U. S. G. S.	140
1.7	1.3	0.7	0.5	0	7.2	1.2	3	0.25	9.6	12	18	6	Randolph	141
1	1	1.4	0.3	0	8.1	2.4	0.6	0.15	6.6	6	2	.....	U. S. G. S.	142
1.1	0.7	0.8	0.6	0	5.4	1.5	0.6	1.2	5.6	20	30	.....	U. S. G. S.	143
0.8	1	1.6	0.1	0	6.8	2.6	0.8	0.20	6.1	11	2.5	.....	U. S. G. S.	144
1.6	1.5	0.8	0.4	0	5	2.4	4	0.3	10.2	6	5	4.2	Randolph	145
2	0.8	2.3	0.7	0	8.3	2.2	2	0.53	8.3	70	120	.....	U. S. G. S.	146
2.5	0.8	2.8	0.6	0	16	1.7	1	0.10	9.5	7	5	.....	U. S. G. S.	147
2.1	1.6	2.6	0.3	0	15	3.8	0.8	0.15	12	4	2.5	.....	U. S. G. S.	148
3.6	1.5	7.8	1.1	0	34	3.6	2	0.46	15	25	20	.....	U. S. G. S.	149
1.8	1.2	1.5	0.7	0	12	1.1	2.2	0.2	9.4	10	25	10	Randolph	150
2.6	1.8	2.2	0.9	0	17	3.1	3	0	13.9	5	7	14.5	Randolph	151
2.2	1.8	2	0.5	2	11.4	2.1	3	0.4	12.9	10	15	10.2	Randolph	152
2.5	1.4	1.1	0.5	0	12	2.1	0.7	0.70	12	4	15	.....	U. S. G. S.	153
3.6	1.8	2.1	0.7	0	20	1.9	0.9	0.44	16	8	12	.....	U. S. G. S.	154
3.7	1	2.5	0.4	0	18	1.8	0.8	0.25	13	8	5	.....	U. S. G. S.	155
2.7	1	2.2	0.3	0	15	1.8	0.6	0.67	11	18	9	.....	U. S. G. S.	156
3	1.4	2.6	0.8	0	17	1.8	1.8	0.50	13	8	15	.....	U. S. G. S.	157
2.4	1.1	2	0.5	0	13	1.8	0.8	0.31	10	20	8	.....	U. S. G. S.	158
2.4	1.2	2	0.3	0	14	1.6	0.6	0.56	11	15	10	.....	U. S. G. S.	159
4.4	1.7	2.7	1	0	22	1.9	1.3	1.5	18	12	10	.....	U. S. G. S.	160
3.7	1.6	2.2	0.5	0	21	2	0.5	1.7	16	15	10	.....	U. S. G. S.	161
3.2	1.1	1.6	0.5	0	16	1.8	1	0.15	13	18	15	.....	U. S. G. S.	162
5.1	1.4	18	1.6	0	22	5.4	25	0.10	18	60	240	.....	U. S. G. S.	163
3.9	1.1	4.4	0.8	0	17	4.2	3.6	0	14	40	25	.....	U. S. G. S.	164
2.5	0.8	1.8	0.6	0	12	2.1	1	0.30	9.5	7	2.5	.....	U. S. G. S.	165
2.9	2.2	2.9	0.9	0	12	2.6	6	0.25	13	5	12	10	Randolph	166
2.8	1	2.7	0.8	0	15	4.6	1.1	0.20	11	7	10	.....	U. S. G. S	167
3.7	1.1	3.5	1.8	0	19	4.5	4	0.6	19.5	7	20	16	Randolph	168
1.7	0.9	2	0.2	0	9.8	2	0.9	0.10	7.9	8	1	.....	U. S. G. S.	169
3.6	0.65	.....	.....	.....	.....	3.3	0	.....	9	53	24	14	?	170(a)
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	171
1.4	0.11	.....	.....	.....	.....	0.98	0	.....	1	33	23	5	?	172(b)
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	173
2.7	0.72	.....	.....	.....	.....	2.8	0	.....	9.5	25	23	8.5	?	174(c)
1.4	0.2	.....	.....	.....	.....	5.5	0	.....	.....	29	23	7	?	175(d)
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	176
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	177
1.2	0.7	1.2	0.4	0	5.6	2.3	0.5	0.12	5.9	6	.....	.....	U. S. G. S.	178
2.2	0.9	2.4	0.4	0	12	1.7	1.1	0.57	9.2	13	8	.....	U. S. G. S.	179
6.2	2.6	1.0	0.5	0.2	24.0	3.2	4.5	0.16	26	9	.....	20	Randolph	181
5.0	1.6	1.0	0.4	0.1	14.2	2.0	5.4	0.21	19	10	20	12	Randolph	182
6.5	0.37	0.41	0	0.3	23.3	4.0	0.25	0	18	10	8	20	Randolph	183

TABLE 3

THE AVERAGE ANALYSIS OF A HYPOTHETICAL STREAM IN THE MOUNTAIN SECTION OF NORTH CAROLINA

	No. of Analyses Considered	Parts Per Million
Silica (SiO_2)	74	10.
Iron (Fe)	74	0.21
Calcium (Ca)	74	2.4
Magnesium (Mg)	74	1.
Sodium (Na)	74	2.2
Potassium (K)	74	0.58
Carbonate radicle (CO_3)	74	0.
Bicarbonate radicle (HCO_3)	74	12.
Sulphate radicle (SO_4)	74	2.4
Chloride radicle (Cl)	74	1.9
Nitrate radicle (NO_3)	72	0.33
Total dissolved solids at 180° C.	74	31.
Total hardness as $CaCO_3$ (calc)	74	10.
Color	73	14.
Turbidity	60	34.
Suspended matter	74	11.
Alkalinity	29	11.

THE PIEDMONT SECTION

With a change hardly perceptible to the ordinary eye insofar as surface features are concerned, the Piedmont section spreads out eastward from the base of the mountains until it merges into the Coastal Plain, where the most immediate visual evidence of the breaking of the plateau into the plain is the "fall line", which is easily observed in the descending streams. This plateau, like the Coastal Plain, is a continuation of the configuration of the Atlantic border region. However, in the Carolinas, it attains a greater width than in any of the states to the north. Situated midway between the Mountain section on the west and the Coastal Plain section to the east, and containing to some extent the best features of each, it is the industrial hub of the "New South" along the Atlantic seaboard. Kerr described this area in the following selection:

"This plateau has along its western margin an altitude of 1,200 to 1,500 feet above sea-level, and is mountainous, with high and precipitous spurs projected eastward and southward from the Blue Ridge. A few of these extend in irregular, straggling

ranges all across the breadth of the Piedmont section, which is 60 to 75 miles wide, and carry an elevation of 1,000 feet to its eastern margin.

"This middle region of the State is a country of hills and valleys and rolling uplands, its prominent topographical features being a succession of broadbacked swells with eastward or southeastward trends, constituting the watersheds between a number of large rivers, which take their rise in the Piedmont or on the flanks of the Blue Ridge, and reach the Atlantic through a system of wide valleys, 300 to 500 feet below the intervening divides. The area of this region is about 20,000 square miles; its altitude, descending gradually from 1,000 to about 200 feet, averages about 650 feet."

Attention is again called to Plates I and II, where it will be found that the approximate lines of demarcation are shown for the three sections of the State and the drainage can be examined. The streams can be referred to more easily on Plate II where the overprint only gives the location of water analysis sampling stations in addition to the outlines of the main drainage basins. The Yadkin, Catawba, Neuse, and Cape Fear rivers are the principal streams of the region.

Practically every ordinary form of industrial activity is represented within this region, and consequently its water resources have been subjected to nearly every industrial use. Innumerable streams furnishing an excellent quality of water still remain to be appropriated. Samples of water have been collected and analyzed from a number of representative streams in this highly industrial area, and the analyses presented herewith will bear witness to the excellence of the waters.

The majority of the analyses are contained in Table 4, while a number of special analyses are presented in Tables 5 and 6. The analyses of Table 5 refer to the Neuse River near Raleigh, and almost without exception each analysis is that of a 10-day composite sample, and the series of analyses cover a period of a year. Further mention of the analyses of this table will shortly be made. The analyses of Table 6 for the Dan River at South Boston, Virginia, were made on the same basis as were those for the Neuse river near Raleigh. Though two decades have passed since they were made, it is believed that current determinations would give practically the same results except in the case of one item. It is probable that a greater per cent of the drainage area is under cultivation at this time in the case of

TABLE 4—Analyses of Surface Waters In
(U. S. G. S. Analyses by M. D.

Water Resources Number	NAME OF STREAM AND APPROXIMATE LOCATION OF SAMPLING POINT	County	Date of Collection	Suspended matter	Total dis'd solids	Silica (SiO_2)	Iron (Fe)
			Analyses in parts per million.				
400	First Broad, west of Shelby, N. C., Highway Bridge Route No. 20	Cleveland	Nov. 29, 1925	20	34	13	0.38
401	Charlotte, municipal; Catawba River filtered (1)	Mecklenburg	Apr. 3,1922	.....	57	8.4	0.09
402	South Fork Catawba, Highway Bridge below dam, ½ mi. east of Lowell, N. C.	Gaston	Nov. 29, 1925	13	50	16	0.40
403	Henry River, Henry Fork, Henry River, N. C.	Catawba	Feb. 11, 1926	5.4	25	8.5	0.10
404	Thomasville City Water	Davidson	July 1, 1927	3.2	53.4	12.4	0.2
405	Yadkin River, South Fork, Salisbury, N. C.	Rowan	July 18, 1927	128	54.82	17.3	0.4
406	Yadkin River, at Salisbury, N. C.	Rowan	Sept. 12, 1925	490	51	12	0.13
407	Yadkin River, near Salisbury, N. C.	Rowan	Nov. 11, 1926	23	56	20	0.78
408	Little River, at Highway No. 74 Crossing	Montgomery	July 26, 1927	31	60.6	9.6	1
409	Rocky River, below dam of Rocky View Milling Co.	Stanly	July 25, 1927	91	57.65	7.4	0.35
410	Uharie River, at No. 109 Highway Bridge near Troy, N. C.	Montgomery	July 26, 1927	144	58.95	13.4	0.7
411	(Long Creek Source) Albemarle City Water Filtered	Stanly	July 18, 1927	4	55.4	13	0.1
412	Monroe Filtered Water, Monroe, N. C.	Union	Aug. 16, 1927	2	63.7	7.6	0.1
413	Stony Creek, Raw Water Lake for Burlington, N. C.	Alamance	June 30, 1927	22.5	57.97	11.3	0.3
414	Reedy Fork Creek, Greensboro, N. C., at Concrete Bridge, gage house	Guilford	June 27, 1927	28	64	14	0.35
415	South Fork of Buffalo Creek, Greensboro, N. C., S. W. of Pomona Mills	Guilford	Jun 27, 1927	26	65	13.2	0.4
416	Haw River, Haw River, N. C.	Alamance	Nov. 30 1925	33	96	20	0.28
417	Haw River at Bynum-Mfg. Co. Mill	Chatham	June 24, 1927	50	54.9	13.3	0.6
418	High Point Filtered Water	Guilford	July 27, 1927	3	59.8	10.6	0.3
419	Deep River West Fork, U. S. G. S. gaging sta. near High Point, N. C.	Guilford	Nov. 27, 1925	25	67	25	0.40
420	Deep River West Fork, near High Point, N. C.	Guilford	Feb. 9, 1926	23	67	24	1.1
421	Deep River near Sanford, N. C., Highway Bridge No. 53	Chatham-Lee	June 30, 1927	50	43.5	12	0.4
422	Dial Creek, near Bahama, N. C., at gaging station	Durham	Jan. 23, 1926	11	68	23	1.3
423	Flat River, near Bahama, N. C., at Weir above Lake Mickie	Durham	Jan. 23, 1926	20	66	19	1.7
424	Durham Municipal Raw Water Supply; Flat River above Lake Mickie	Durham	June 5, 1927	62	62.8	15	0.7
425	Neuse River, near Raleigh, N. C. (2)	Wake	Oct. 1, 1906 Oct. 1, 1907	68	73	26	1.4
426	Neuse River, Highway Bridge, Route No. 90 out of Raleigh, N. C.	Wake	June 10, 1927	70	63.8	17.2	0.4
427	Little Creek, Zebulon, N. C.	Wake	Jan. 30, 1926	139	69	17	1.5
428	Tar River at Providence	Granville	July 26, 1927	106	109.9	19.9	2.3
429	Gastonia, N. C. Municipal Supply, Raw water at intake	Gaston	Nov. 13, 1925		See table 5.		
430	Gastonia, N. C. Municipal Supply, Filtered	Gaston	Nov. 13, 1925		See table 5.		
431	Charlotte, N. C. Municipal Supply; Catawba River, Filtered	Mecklenburg	Oct. 22, 1925		See table 5.		
432	Third Creek, near Statesville, N. C.	Iredell	Dec. 22, 1925		See table 4.		
433	South Yadkin River, near Statesville, N. C	Iredell	Dec. 22, 1925		See table 4.		
434	Snow Creek, near Statesville, N. C.	Iredell	Dec. 22, 1925		See table 4.		
435	Morrison Creek, raw water, 5.3 mi. from Statesville, N. C.	Iredell	.....	10	68	11.5	1.2 (a)

(1) This analysis, designated as No. 203, is described on pages 48 and 49 of the U. S. Geological Survey Water Supply Pape 496 (1923).

(2) These results are the averages of the analyses of 34 composite samples, each one being representative of a ten day period For the results of the 34 individual determinations, see page 39 of the U. S. Geological Survey Professional Paper 135, "Th Composition of the River and Lake Waters of the United States."—1924.

(a) Iron, reported here as ferric oxide (Fe_2O_3).

(b) Total of mineral constituents as determined, 62.33 p. p. m.

(c) Total of mineral constituents as determined, 85.5 p. p. m.; residue on evaporation, 113 p. p. m.

The Piedmont Section of North Carolina.
Foster, Quality of Water Division)

Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate radicle (CO_3)	Bicarbonate radicle (HCO_3)	Sulfate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Total Hard'ss Cal'd ($CaCO_3$)	Color	Turbidity	Alkalinity	Authority	Water Resources Number
Analyses in parts per million.														
2.7	1.3	2.4	0.7	0	17	2.3	1.5	0.50	12	18	10	.....	U. S. G. S.	400
11	2.2	2	0.8	0	16	23	1.5	0.43	37	.....	.....	.....	U. S. G. S.	401
4.10	1.8	2.8	0.9	0	22	3	2.1	1	18	22	25	.....	U. S. G. S.	402
1.70	1	1.3	0.6	0	8.5	2.7	1.2	0.38	8.4	9	10	.....	U. S. G. S.	403
7.2	1.1	2.8	0.8	0	15.8	8	3	0	18	5	7	13.2	Randolph	404
4.1	1.8	2.5	0.8	0	17.3	4.5	4	0.12	17.6	20	200	17.3	Randolph	405
5	1.7	4	1.7	0	21	5	3.5	1.5	19	18	1000	.....	U. S. G. S.	406
4.2	2	2.9	0.7	0	22	3.9	2.2	0.60	19	60	33	.....	U. S. G. S.	407
4.4	1.6	6.4	1.8	0	17	9.6	9	0.2	18	20	60	15	Randolph	408
4	3.6	3.3	1.5	0	22	5.1	7	0.5	24	18	90	18.2	Randolph	409
4.5	2.1	3.2	1.2	0	14	6.6	8	0.15	19.8	12	125	12	Randolph	410
5.4	2	2.6	0.9	0	18	4.7	7	0.2	21.7	10	10	15	Randolph	411
10	0.7	5.1	1.2	0	18	9.8	11	0.2	27.8	7	8	15	Randolph	412
7.5	1.1	3.0	0.5	0	24	4	5	0.27	23	10	20	20.4	Randolph	413
4.8	2.7	4.2	0.8	0	28	4	4.4	0.45	23	12	40	25	Randolph	414
5.1	2.5	4.5	0.7	0	30	3.2	5.2	0.36	22	13	42	26	Randolph	415
7.3	2.9	12	2.3	0	38	11	10	2.5	30	25	25	.....	U. S. G. S.	416
5.1	1.1	2.7	0.7	0	19.1	3.3	7.5	0.3	17.2	15	42	16	Randolph	417
6.6	2.1	2.5	1.1	0	25	6.4	4	0.2	25	5	7	21	Randolph	418
5.8	2.3	4.9	0.9	0	37	2.6	2.1	0.12	24	30	25	.....	U. S. G. S.	419
4.7	2.6	4	0.7	0	28	3.8	2	0.42	22	65	25	.....	U. S. G. S.	420
3.1	0.9	3	0.7	0	13.5	3.7	3.1	0.8	11.4	20	70	11.5	Randolph	421
3.8	1.7	4.6	0.5	0	14	8.6	4.5	0.54	16	90	25	.....	U. S. G. S.	422
3.7	1.7	3.4	0.8	0	11	7.1	4.1	1.7	16	120	35	.....	U. S. G. S.	423
6.2	1.8	3.8	0.7	0	23	6.2	4.4	1	23	25	80	20	Randolph	424
5.9	1.8	7.9	.....	0	35	3.4	4.4	0.3	.....	.....	78	.....	U. S. G. S.	425
5.9	1.4	7.1	1.3	0	13.2	3.1	10	1.4	20.5	15	60	11	Randolph	426
2.9	1.2	4.9	1	0	16	6	2.5	1.3	12	150	110	.....	U. S. G. S.	427
7.2	3.9	10	1.5	0	36	16.8	7	1.3	33.9	30	225	30	Randolph	428
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	429
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	430
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	431
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	432
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	433
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	434
8.3	2.5	2.15	.....	.....	15	6	3.1	6.7	15.2	.....	.....	.....	Randolph	435

TABLE 4—

Water Resources Number	NAME OF STREAM AND APPROXIMATE LOCATION OF SAMPLING POINT	County	Date of Collection	Suspended matter	Total dis'd solids	Silica (SiO_2)	Iron (Fe)
				Analyses in parts per million.			
435-a	Morrison Creek, filtered water	Iredell		0	49	9.1	0.95(a)
436	Fourth Creek, raw water	Iredell		13	70	12.3	0.95 (a)
436-a	Fourth Creek, filtered water	Iredell		0	46	8.5	0.9 (a)
437	Yadkin River, near Salisbury, N. C.	Rowan			See table 4.		
438	Yadkin River, main stream	Rowan	Mar. 28, 1925		See table 4.		
439	Yadkin River, north fork	Rowan	Mar. 28, 1925		See table 4.		
440	Salisbury, N. C. municipal supply; filtered water, N. fork of Yadkin	Rowan	Feb. 6, 1926	6	47	7.51	0.1
441	Hogan Creek, Reidsville, N. C.	Rockingham	Jan. 14, 1926		See table 4.		
442	Greensboro Impounded Supply Horsepen & Reedy Fork Creeks	Guilford	Jan. 14, 1926		See table 5.		
443	Haw River, Burlington, N. C.	Alamance	Oct. 31, 1925		See table 4.		
444	Statesville, N. C. municipal supply; filtered	Iredell	Jan. 11, 1926	0	43	8.2	0.92 (a)
445	Tallassee Power Co., Badin, N. C., raw water supply, Lake Tallassee, Stored Yadkin River Water	Stanly	Apr. 21, 1919		136	36	12
446	Tallassee Power Co., Badin Supply; Yadkin River; filtered	Stanly	Apr. 21, 1919		66.6	12.9	3.4
447	Statesville City Water, Filter Plant	Iredell	June 11, 1926	1	47	8.2	0.42
448	Fourth Creek, near Statesville, N. C.	Iredell	Jan. 11, 1926	10	51.5	15.5	0.5
449	Morrison Creek, near Statesville, N. C.	Iredell	Jan. 11, 1926	20	58	15.6	0.38
450	Haw River, at Bridge Route No. 10	Alamance		50	78	6	0.32
451	Deep River, near Bridge on Highway No. 75	Chatham-Lee		30	52	15	0.35
452	Burlington City Water; Stony Creek, filtered	Alamance	Jan. 13, 1926	2	43	16	0.23
453	Hickory City Water, Hickory, N. C.	Catawba	Dec. 23, 1925	2	41.3	12	0.2
454	Catawba River, near Hickory, N. C.	Catawba	Dec. 23, 1925	45	48	17	0.4
455	Oxford, N. C., municipal supply; Tar River, filtered	Granville	June 2, 1926	1	49	6.8	0.38
456	Raleigh, N. C. filtered water from spigot at State College Lab	Wake	May 8, 1927	1	42	8.2	0.2
457	Crabtree Creek, at Lassiter's Mill near Raleigh, N. C.	Wake	May 11, 1927	17	52	13	0.3
458	Neuse River, at bridge on Wendell Road near Raleigh, N. C.	Wake	May 11, 1927	18	55	16	0.35
459	Peedee River, at Bridge on Highway No. 74	Stanly	Apr. 12, 1926	150	50	14	0.3
460	Broad River, Boiling Springs, N. C.	Cleveland	Feb. 9, 1926	87	49	17	1
461	Yadkin River, near Salisbury	Rowan	Dec. 3, 1927		(b)	7.7	0.47
462	Yadkin River, raw water storage to Badin Filter Plant	Stanley	Nov. 25, 1927			40.5	6.1
463 (c)	Badin, N. C. filtered water from the Yadkin River	Stanley	Nov. 25, 1927			9.7	0.2

4
4
435

(1) T
496 (1923).
(2) The
For the result
Composition o
(a) Iron, re
(b) Total o
(c) Total of

Continued

Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate radicle (CO_3)	Bicarbonate radicle (HCO_3)	Sulfate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Total Hard'ss Cal'd ($CaCO_3$)	Color	Turbidity	Alkalinity	Authority	Water Resources Number
Analyses in parts per million.														
6.1	2	2.15	.....	.....	18	5.6	3.1	0.4	14.3	.....	.....	.....	Randolph	435-a
6.5	2.2	2.1	.....	.....	18.9	6.9	2.8	0.6	16.2	.....	.....	.....	Randolph	436
5.4	1.6	2.1	.....	.....	18.9	6.6	2.8	0.32	14.4	.....	.....	.....	Randolph	436-a
4.7	1.3	.....	.....	0	16.7	7.3	4.7	.....	9.1	.....	.....	12	Industrial Fibre Co., Cleveland, Ohio	440
5.8	1.2	0.8	.....	0	18.6	6.2	2.4	.25	14.3	.....	.....	.....	Randolph	444
8.2	5.2	6.1	.....	.....	.....	14.1	3.5	.....	.....	.....	350	18		445
4	1.3	6	.....	.....	.....	15.6	3.5	.....	.....	.....	Tr.	11		446
5.8	1.2	1	0.8	0	18.6	6.2	4.4	0.25	18	7	8	15	Randolph	447
5.4	1.6	2.1	0.5	0	18.9	1.9	4.8	0.3	20	10	30	15	Randolph	448
6.1	2	2.2	0.4	0	18	5.6	3.1	0.4	24	12	30	18	Randolph	449
6.5	2.4	10	1.5	0	30	7.5	12	1	26	10	65	25	Randolph	450
5.5	0.8	2.9	0.7	0	22	2.8	2.3	0.2	17	8	35	18	Randolph	451
2.2	1.3	3	0.27	0	14.4	4	1.2	0.2	14	7	8	12	Randolph	452
3	1.1	2.8	0.8	0	16	4.2	1	0.2	14	10	10	14	Randolph	453
2	1.5	3.7	1.2	0	14.1	2.3	4.9	0.35	13	12	55	13	Randolph	454
6.2	1.8	1.6	0.8	0	26.6	1.9	2.6	0.15	23	9	7	21	Randolph	455
5	1	1.6	0.9	0	19	2.1	2.5	0.15	17	7	6	15	Randolph	456
6.2	1.3	1.6	1.4	0	18	4.6	4.8	0.5	29	7	45	15	Randolph	457
5.4	1.6	2.5	1.3	0	16.5	3.2	7.2	0.9	14	7	36	14	Randolph	458
5.4	1	2	0.9	0	21	3	2	0.3	18	15	170	18	Randolph	459
2.9	1.6	3.3	0.6	0	17	3.3	2	1.3	14	86	45	.....	U. S. G. S.	460
12.7	1.4	2.7	.....	2.81	.....	30.23	3.25	1.25	37.7	.....	.....	4.7	Ramage	461
4	2.2	6.5	.....	.....	28.1	4.1	6	0.3	19	.....	250	23	W. E. Giles	462
3.4	1.8	17.9	.....	.....	28.1	15.9	4.5	0.1	15.9	.....	.....	23	W. E. Giles	463(c)

each stream, and consequently it is probable that the turbidity would average slightly higher.

The Virginia analysis is included because the Dan River rises in North Carolina to form the main stream of Stokes County, whence it flows into Virginia as a tributary to the Roanoke River, a Virginia stream which subsequently flows through the northeastern section of the Coastal Plain of North Carolina to empty into Albemarle Sound.

Table 7 gives an average analysis of all the samples of untreated surface water in Table 4. It will be seen that this analysis compares most advantageously with typical analyses from streams in other states as indicated in Table 15. Especial attention is called to the low hardness of the Piedmont waters.

TABLE 5—Analyses of Water from Neuse River near Raleigh, N. C.[a]

[Parts per Million]

Date (1906-7). From—	Date (1906-7). To—	Turbidity.	Suspended matter.	Coefficient of fineness.	Total iron (Fe).	Silica (SiO_2).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium and potassium (Na+K).	Carbonate radicle (CO_3).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Nitrate radicle (NO_3).	Chlorine (Cl).	Total dissolved solids.
Oct. 1	Oct. 10	14	13	0.93	0.9	25	0.4	5.2	1.8	7.1	0.0	.....	2.6	0.0	3.8	68
11	20	14	11	.78	.5	27	.4	5.6	1.2	7.2	.0	39	1.0	Tr.	3.8	66
21	30	24	18	.75	.8	25	.4	6.0	1.2	7.9	.0	44	1.2	.0	4.6	68
Nov. 1	Nov. 10	10	5.8	.58	.8	20	.4	7.2	1.8	8.2	.0	39	3.0	.2	5.0	69
11	20	11	7.6	.69	.9	21	.3	5.4	1.6	7.7	0.0	37	2.8	.2	4.6	63
21	30	9	5.8	.64	.5	21	.3	6.0	2.0	8.2	.0	40	2.8	Tr.	5.2	65
Dec. 1	Dec. 10	11	3.8	.34	.4	22	.3	5.6	1.8	8.0	.0	41	2.8	.0	4.8	65
11	20	26	16	.61	1.4	22	.65	6.4	1.6	8.0	.0	37	2.1	Tr.	5.8	68
21	30	45	29	.64	2.1	22	1.8	6.0	2.4	6.5	.0	32	2.3	Tr.	6.5	74
31	Jan. 9	17	9.0	.53	1.3	21	.9	5.6	1.6	6.8	.0	35	1.8	Tr.	6.5	68
Jan. 10	19	11	6.8	.62	1.0	22	.8	6.8	2.8	7.9	.0	39	3.5	Tr.	5.9	66
20	29	8	3.4	.42	.9	21	.6	6.4	2.6	7.8	.0	40	2.8	Tr.	5.9	65
30	Feb. 8	15	10	.67	1.3	20	.8	6.2	2.6	6.3	.0	37	2.8	Tr.	.....	67
Feb. 9	18	29	18	.62	1.5	22	1.4	5.8	1.8	6.0	.0	36	3.1	Tr.	.....	72
19	28	.....	72	.....	3.9	22	1.7	5.6	1.4	6.0	.0	23	4.9	.7	4.7	79
Mar. 1	Mar 10	33	12	.36	2.1	22	2.0	5.0	1.2	7.6	.0	25	3.3	.5	4.1	76
12	21	.....	77	.....	2.8	26	2.6	4.8	1.2	6.9	.0	23	4.6	.6	3.5	85
22	31	18	20	1.11	1.0	22	.6	6.0	1.8	6.8	[b]2.4	28	2.0	.0	3.8	63
Apr. 1	Apr. 10	48	45	.94	1.8	16	1.3	5.8	1.6	8.2	.0	33	4.1	.5	5.0	62
11	21	27	19	.70	1.3	39	1.2	6.8	1.8	8.8	.0	40	3.6	.5	5.4	93
22	May 2	81	73	.90	2.7	23	2.0	6.4	1.7	8.8	.0	32	4.8	1.0	4.2	77
May 3	12	82	67	.82	2.4	28	2.1	6.0	1.4	9.3	.0	32	3.5	.7	4.6	82
13	22	28	39	1.40	1.3	30	.95	6.2	1.8	11	[b]4.8	29	2.8	Tr.	4.2	78
23	June 1	53	57	1.08	1.8	22	.9	6.4	1.8	.....	.0	35	3.3	.9	3.8	66
June 3	12	100	96	.96	1.8	32	1.7	5.4	.8	10	.0	34	4.4	.0	3.6	90
13	22	325	247	.76	7.4	24	2.0	5.6	.8	8.2	.0	28	4.3	1.2	3.0	79
23	July 2	325	280	.86	1.3	39	3.7	8.2	2.0	12	.0	50	3.6	Tr.	4.6	.....
July 3	12	48	50	1.04	1.6	24	.9	6.6	.....	9.1	.0	37	3.5	.0	3.6	71
13	23	160	333	2.08	1.9	24	1.8	4.8	.....	8.5	.0	35	3.3	Tr.	3.0	74
24	Aug. 1	120	82	.68	1.6	24	1.5	6.4	3.0	6.3	.0	37	3.9	.8	3.2	75
Aug. 3	12	540	428	.79	7.0	43	5.2	3.8	1.9	5.4	.0	18	7.6	.6	3.8	.....
13	22	70	26	.37	2.6	32	2.2	5.8	.....	5.7	.0	30	3.8	.5	3.2	89
23	Sept. 1	40	37	.92	2.6	26	.66	6.8	.....	.....	.0	38	4.6	.6	4.2	75
Sept. 2	11	170	113	.66	1.4	33	3.1	4.8	.....	7.6	.0	32	3.3	.6	.....	.....
12	21	30	28	.93	3.5	28	.8	6.4	3.4	9.4	.0	44	3.6	.5	4.2	81
22	Oct. 1	120	76	.63	7.0	29	2.0	5.4	2.4	7.9	.0	34	3.9	.5	3.8	84
Mean.	.....	78	68	.79	2.8	26	1.4	5.9	1.8	7.9	.0	35	3.4	.3	4.4	73

[a] Analyses Oct. 1 to 3, Dec. 10, 1906, by R. B. Dole; Dec. 11, 1906, to Mar. 31, 1907, by R. B. Dole and M. G. Roberts; Apr. 1 to July 2, 1907, by Chase Palmer and M. G. Roberts; July 3 to Oct. 1, 1907, by R. B. Dole, Chase Palmer and W. D. Collins, all associated with the U. S. Geological Survey.

[b] Abnormal; computed as HCO_3 in the average.

TABLE 6—Analyses of Water from Dan River at South Boston, Va.[a]

[Parts per Million]

Date (1906-7). From—	To—	Turbidity.	Suspended matter.	Coefficient of fineness.	Total iron (Fe).	Silica (SiO_2).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium and potassium ($Na^+ K$).	Carbonate radicle (CO_3).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Nitrate radicle (NO_3).	Chlorine (Cl).	Total dissolved solids.	Mean gage height (feet).
Sept. 3	Sept. 13	210	126	0.60	8.9	26	1.4	6.0	2.8	4.2	0.0	41	1.3	Tr.	2.4	75	3.2
Oct. 1	Oct. 11	260	175	.67	9.8	31	2.1	5.2	1.8	7.6	.0	34	2.5	0.8	2.6	82	4.2
12	21	43	42	.98	2.4	50	.7	6.0	2.2	8.5	.0	39	2.6	Tr.	3.1	100	4.3
22	31	31	25	.81	1.4	23	.6	5.2	2.0	7.6	.0	36	2.3	Tr.	2.4	61	4.8
Nov. 1	Nov. 11	17	23	1.94	1.0	17	.07	5.2	1.6	5.2	.0	34	2.8	.6	3.4	52	2.5
12	21	230	181	.79	8.4	21	1.3	4.8	1.2	5.4	.0	30	3.3	1.6	2.7	67	2.7
22	Dec. 1	28	131	.47	2.0	16	.3	5.6	1.4	6.3	.0	32	4.3	.6	2.6	54	2.3
Dec. 2	12	21	76	3.62	3.5	18	.28	5.4	1.8	4.9	.0	35	1.6	.5	3.0	50	2.3
13	23	220	664	3.00	16	26	2.2	4.4	1.6	6.8	.0	33	4.3	1.1	3.4	78	2.6
24	31	350	742	2.12	24	23	1.8	4.6	1.8	6.0	.0	29	4.3	1.6	2.9	69	3.5
Jan. 3	Jan. 13	55	525	9.54	10	16	.35	4.8	1.8	6.2	.0	31	2.8	1.6	3.4	54	4.5
20	29	110	815	7.41	9.5	21	1.0	5.6	2.0	6.5	.0	40	3.1	Tr.	4.1	75	2.7
30	Feb. 9	90	215	2.39	6.5	23	1.0	6.2	2.0	6.2	.0	40	3.5	.2	3.6	77	2.8
Feb. 10	19	175	324	1.85	11	23	2.2	5.4	1.0	6.5	.0	25	4.1	2.1	2.9	75	3.1
20	Mar. 2	110	209	1.90	8.0	25	2.2	6.0	1.2	6.6	.0	24	5.8	1.8	2.5	84	2.9
Mar. 3	12	380	677	1.78	9.0	24	2.4	5.8	.6	7.7	.0	26	4.0	1.9	3.1	86	5.1
13	24	47	231	4.9	5.3	18	.33	7.8	.8	6.8	.0	28	5.3	2.4	4.1	66	4.6
25	Apr. 3	27	45	1.67	1.4	16	.08	6.8	.8	9.5	b16	3.0	5.1	.0	5.3	64	2.6
Apr. 4	13	225	150	.67	10	28	1.0	6.0	1.1	9.4	.0	40	3.6	3.0	3.1	88	4.9
14	23	38	44	1.16	2.3	18	.24	5.6	1.6	6.3	.0	29	2.5	1.8	3.4	55	2.7
24	May 2	98	110	1.12	6.5	31	1.1	5.6	1.0	8.2	.0	30	2.8	1.8	4.2	86	4.2
Mean.....		132	264	2.35	7.5	24	1.1	5.6	1.5	6.8	0	33	3.4	1.1	3.2	71	.....

[a]Analyses Sept. 3 to Oct. 31, 1906, by R. B. Dole; Nov. 1, 1906, to Apr. 3, 1907, by R. B. Dole and M. G. Roberts; Apr. 4 to May 2, 1907, by Chase Palmer and M. G. Roberts, all associated with the U. S. Geological Survey.

[b]Abnormal; computed as HCO_3 in the average.

TABLE 7

THE AVERAGE ANALYSIS OF A HYPOTHETICAL STREAM IN THE PIEDMONT SECTION OF NORTH CAROLINA

	No. of Analyses Considered	Parts Per Million
Silica (SiO_2)	38	16.
Iron (Fe)	37	0.81
Calcium (Ca)	38	5.2
Magnesium (Mg)	38	1.9
Sodium (Na)	38	4.2
Potassium (K)	32	0.98
Carbonate radicle (CO_3)	34	0.0
Bicarbonate radicle (HCO_3)	36	21.
Sulphate radicle (SO_4)	38	5.9
Chloride radicle (Cl)	38	4.6
Nitrate radicle (NO_3)	37	0.83
Total dissolved solids at 180° C.	36	62.
Total hardness as $CaCO_3$ (calc.)	36	20.
Color	32	31.
Turbidity	35	102.
Suspended matter	35	61.
Alkalinity	33	18.

THE COASTAL PLAIN SECTION

The Coastal Plain section along its western margin has an average altitude of about 200 feet. From there it slopes rather sharply at first and then more gently in terraces until it approaches tide level "where it embraces swamps, marshes, bays, and sounds over wide areas—the whole surface for more than 50 miles inland from Hatteras and the eastern shore being less than 20 feet above sea-level." The total width of the plain reaches 125 miles. Its area is about two-fifths that of the State, exceeding 20,000 square miles and embracing wholly or in part forty-two counties.[1]

The boundary line between this section, and its neighbor on the west, the Piedmont section, is in a general way, a line[2] crossing the Roanoke river just to the northeast of Thelma in Halifax County, running as a curvilinear line in an approximately southwest direction so that by swinging eastward, it just manages

[1]Clark, in the "Coastal Plain of North Carolina".

[2]For the exact location of this line as it has been determined, see "The Coastal Plain of North Carolina," Vol. III, Plate XVII; Pratt and Clark, 1912; North Carolina Geological and Economic Survey.

to leave Raleigh in the Piedmont section, and then to pass through Sanford on its way into South Carolina via Wadesboro in Anson County. The shape and general direction of the line conforms somewhat roughly to the shore line of the coast.

Passing through Eastern North Carolina and draining into the Atlantic Ocean, we find beginning in the north and glancing southward: the Pasquotank, Chowan, Roanoke, Tar, Neuse, Cape Fear, and Lumber rivers as the streams draining the main river basins with the Yadkin (Pee Dee) cutting across the extreme southeastern boundary. A more concrete conception of the Coastal Plain section in relation to its extent and the streams therein, can be gained by reference to Plate II where it will be found that for convenience, the line of demarcation has been made to follow the county lines as an approximation. It will be noticed that the streams of the Coastal Plain section are of two types: first, those that have their origin in the Piedmont Plateau, and flow across the Coastal Plain on their way to the sea, and second, those that have their origin in the Coastal Plain deposits and are not influenced by the geological and topographic features of the Piedmont region. The streams previously mentioned are of the first type. The streams of the second type are too numerous to mention.

The original intention of the Department in undertaking its survey of the State with regard to the chemical quality of the water was to start in the west, working eastward as its activities and funds would permit. The principal reason for this decision was that water samples could be collected only at times when the personnel of either its Water Resources Division or of the U. S. Geological Survey had occasion to travel in connection with other activities, and principally this has been stream gaging in the central and western part of the State. The fact that the North Carolina Geological Survey had previously published a large number of analyses for the eastern part of the State was also a factor affecting the decision. The result is that the Department, in presenting this preliminary publication, can not offer a great many analyses for the surface waters of the Coastal Plain. In Table 8, such recent analyses as the Department has been able to obtain have been segregated as between sources of surface and underground supplies. In Table 9, a

tabulation of analyses referring to the Pee Dee (Yadkin) River near Pee Dee, N. C., will be found. The individual analyses are of 10-day composite samples, and the series covers a period of approximately a year. Similar data is contained in Table 10 with reference to the Roanoke river at Randolph, Va., and in Table 11 with reference to the Cape Fear river at Wilmington, N. C. The analyses of Tables 9 and 11 were made by chemists associated with the United States Geological Survey.

The surface waters of the Coastal Plain contain an average of 55 to 70 parts per million of dissolved solids. The hardness ranges from about 15 to 30 parts per million. Some of the waters whose sources are in the swampy lands are colored from tannic, gallic, and other acids and organic dyes, but as a rule the color is removed by the usual methods of filtration, and its presence is not particularly objectionable. Table 12 presents an average analysis of the untreated surface waters of Table 15, and indicates the presence of excellent waters for industrial use.

The underground waters are more highly charged with chemicals than are the surface waters in many instances, but that is not always the case. The municipal supply at Kinston, it will be noted, has an underground supply that compares very favorably with what would be considered a good surface supply. A point in favor of an underground water supply is its lower temperature. In most localities of this section, a supply can be obtained from both surface and underground sources or from either one depending on the particular need.

UNDERGROUND WATER RESOURCES

The analytical work furnishing the data for this report was not carried on with a view to determining the quality of the underground water resources of the State, but in the Coastal Plain section, this major source is of such great importance that detailed reference is made to it here. A great deal of intensive study and investigation has been devoted to these waters and water bearing formations by geologists, though such work has slackened in recent years. Attention has already been called to the publications of the North Carolina Geological and Economic Survey on this section: Vol. III, The Coastal Plain

TABLE 8—Analyses of Waters in The
(U. S. G. S. Analyses by M. D.

Water Resources Number	NAME OF STREAM AND APPROXIMATE LOCATION OF SAMPLING POINT	County	Date of Collection	Suspended matter	Total dis'd solids	Silica (SiO_2)	Iron (Fe)
	Analyses in parts per million.						
	SURFACE WATERS						
800	Peedee River, near Peedee, N. C.....(a)	Anson.....	Oct. 26, 1906... Oct. 19, 1907...	94	69	26	0.31
801	Drowning Creek, at Blue's Bridge.....	Moore.....	July 30, 1927...	16	38.4	11.1	0.5
802	Lumberton City Water.....	Robeson.....	June 30, 1927...	6.2	47.4	6.8	0.4
803	Lumber River, Intake for Lumberton Water Supply.....	Robeson.....	June 30, 1927...	20	43.9	15.2	0.4
804	Lake Waccamaw, Below dam.....	Columbus.....	June 30, 1927...	10.5	50.7	7.7	0.2
805	Big Coharrie Creek, Highway Bridge, R. No. 23 near Ingold.....	Sampson.....	Aug. 18, 1927...	18	44.4	5.2	0.4
806	North East Cape Fear River.....	New Hanover.....	A g. 7, 1927....	42	85	9.8	0.5
807	Wilmington, municipal; Cape Fear River. (b)	New Hanover.... Oct. 9, 1907....	Oct. 2, 1906....	21	57	9.9	0.78
808	Wilmington, N. C. municipal filtered water.	New Hanover.....	Aug. 6, 1927....	2	63	7.6	0.3
809	Wilmington Filtered.....	New Hanover.....	July 26, 1927...	3	70.7	17	0.5
810	White Lake in Bladen County, at end of pier about 75 ft. from shore.....	Bladen.....	July 8, 1927....	8.5	49	18	0.1
811	New River, at Jacksonville.....	Onslow.....	Aug. 18, 1927...	12	899	15	0.2
812	Neuse River, at Smithfield.....	Johnson.....	July 10, 1927...	46.3	66.8	18.9	1.6
813	Neuse River, Highway No. 10 at Bridge E. of Kinston.....	Lenoir.....	July 13, 1927...	84	59.8	14.7	1.2
814	Tar River, Intake well of Rocky Mount Water Supply.....	Edgecombe.....	June 10, 1927...	140	49.9	11.8	0.4
815	Rocky Mount, N. C., municipal supply; Tar River, filtered, tap.....	Edgecombe.....	June 10, 1927...	4.2	56.5	13	0.3
816	Greenville, N. C., municipal supply; Tar River, filtered.....	Pitt.....	Aug. 12, 1927...	9	85	13	0.4
817	Roanoke River, Old Gaston Gaging Station near Thelma, N. C.....	Halifax.....	July 26, 1927...	65	65.9	12.1	1.6
818	Arm of Roanoke River, at Weldon Plant (Raw Water).....	Northampton.....	Sept. 9, 1927....	80	66	14	1.4
819	Weldon, N. C., municipal supply; Roanoke River, filtered; tap.....	Halifax.....	Sept. 9, 1927....	3	54.2	12	0.6
820	Roanoke River at Weldon, N. C., below canal.....	Northampton Halifax.....	Sept. 9, 1927....	85	76.4	13	1
821	Southern Pines, N. C., municipal supply; raw water; Creek at intake.....	Moore.....	Apr. 18, 1927...	.....	14	.....	0.1
822	Southern Pines, N. C., municipal supply; filtered.....	Moore.....	Apr. 18, 1927...	.....	29	.....	Tr. (e)
827	Little River, at Vass.....	Moore.....	.....	1	52	7.6	0.2
823	Temple Creek, near Sanford, N. C.....	Lee.....	Dec. —, 1925...		See table 5.		
824	Teague & Johnson Creek, South of Sanford, N. C.....	Lee.....	Dec. —, 1924...		See table 5.		
825	Toomer's Creek.....	New Hanover.....	Aug. 8, 1927....	48	88	12	0.2
826	Cape Fear, below Carolina Power & Light Co.'s Steam Plant.....	Chatham-Lee.....	.....	50	53	9.5	0.32
	UNDERGROUND WATERS						
1000	Kinston, N. C. municipal well; 190 ft. deep, near municipal pumping plant.....	Lenoir.....	Feb. 19, 1926...	.....	130	13	0.08
1001	Artesian flowing well; 150 ft. deep, Lake Waccamaw, adjacent to dam.....	Columbus.....	June 30, 1927...	10	368.45	13.4	0.15
1002	Kinston, N. C. municipal well; 562 ft. deep.	Lenoir.....	Feb. 19, 1926...	.....	234	15	0.41
1003	Kinston, N. C. municipal well; 170 ft. deep.	Lenoir.....	Feb. 19, 1926...	.....	141	18	0.15
1004	Kinston, N. C. municipal well; 362 ft. deep, pump house (municipal).....	Lenoir.....	July 13, 1927...	4	88.55	5.5	0.1
1005	New Bern, N. C. municipal system; water from deep wells; tap.....	Craven.....	July 25, 1927...	12	1089.9	19.8	0.3
1006	Deep Well (250 ft.) flowing, Belhaven, N. C	Beaufort.....	Aug. 14, 1927	22	350	10.2	0.6
1007	Belhaven, N. C. municipal well; 100 ft. deep..	Beaufort.....	Aug. 14, 1927...	28	310	12	0.5
1008	Morehead City Wells; five, 250 ft. deep, sample from tap.....	Carteret.....	July 11, 1927...	5	208.9	12	0.5
1010	Murfreesboro, N. C., well 300 ft. deep; used for town supply.....	Hertford.....	Aug. 8, 1925....	.....	183	28	0.03
1009	Well Swansboro, 45 ft. deep; owned by Interstate Cooperage Co.....	Onslow.....	Aug. 4, 1927....	38	298	17.3	6.7

(a) These results are the average of the analyses of 24 composite samples, most of them being representative of a ten day period. For the results of the 24 individual determinations, see page 40 of the U. S. Geological Survey Professional Paper 135, "The Composition of the River and Lake Waters of the United States."—1924.

(aa) Analyses Oct. 26, 1906, to May 1, 1907, by Jas. R. Evans; May 2 to June 28, 1907, by W. D. Collins; June 29 to Oct. 19, by R. B. Dole, Chase Palmer, and W. D. Collins.

(b) These results are the average of the analyses of 30 composite samples most of them being representative of a ten day period. For the results of the 30 individual determinations, see page 39 of the U. S. Geological Survey Professional Paper 135, "The Composition of the River and Lake Waters of the United States."—1924.

(bb) Na plus K, 7.2.

Coastal Plain Section of North Carolina
Foster, Quality of Water Division)

Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate radicle (CO_3)	Bicarbonate radicle (HCO_3)	Sulfate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Total Hard'ss Ca'd ($CaCO_3$)	Color	Turbidity	Alkalinity	Authority	Water Resources Number
Analyses in parts per million. SURFACE WATERS														
		Na plus K											(aa)	
6.9	1.3	8.9	8.9	0	32	4	3.1	0.6	.....	.....	131	.....	U. S. G. S.	800
2.3	2.1	2.4	0.5	0	9.4	3.9	6	0.2	14.36	50	20	8	Randolph	801
5.9	1.5	2.4	0.5	1.2	16.8	4.5	4	0	20.9	60	8	15	Randolph	802
2.5	1.5	2.3	0.5	0	13	2.1	4	0.3	12.4	70	11	12	Randolph	803
6.9	1	3.2	1	0	12.6	5.3	9.6	0.7	21.4	10	12	10.8	Randolph	804
2.3	3.2	4.3	1.2	0	15	3.6	9	0.2	19	55	30	13	Randolph	805
5.5	2.2	13	2	0	34	5.6	13	1.5	23	70	50	28	Randolph	806
5	1.5	7.2	(bb)	0	25	3.2	5.8	0.2	.....	.....	73	.....	U. S. G. S.	807
8.7	2	4.6	0.8	0	16	13.2	10	0.3	30	10	12	15	Randolph	808
6.2	1.4	5.5	1	0	24	4	8	0.1	21.2	5	7	20	Randolph	809
6.1	1.5	1.9	0.8	0	0	6.8	13	0.4	13.9	5	7	(d)	Randolph	810
24	1.4	300	3.5	0	54	75	426	0.5	65.7	70	15	45	Randolph	811
4.1	1.2	6	1.4	0	19	3.3	8	0.8	15.1	15	60	23	Randolph	812
3.8	1.2	6.5	1.3	0	18	2.3	8	0.7	14.4	15	78	15	Randolph	813
2.5	2	4.2	0.8	0	13.8	6.3	5	0.6	14.5	30	225	11.4	Randolph	814
3.7	2.1	5.1	0.8	0	18.6	5.6	6	0	17.9	10	8	15.6	Randolph	815
5.1	2.6	10	2	0	34	13	4.4	0.6	23	8	12	29	Randolph	816
5.6	2.9	2.5	1	0	20.4	7	6	1.2	25.9	20	100	17	Randolph	817
6	2.7	4	0.9	0	23	6.8	6.2	1	26	24	95	20	Randolph	818
5.2	1.4	4.2	0.9	0	18	5	6.5	0.4	19	12	7	15	Randolph	819
6.1	2.6	8.5	1	0	25	6.2	12.5	0.5	27	24	100	21	Randolph	820
Tr.	Tr.	.....	.....	.....	.....	Tr.	1	0.02	1.6(c)	2	5	5	Morris Knowles	821
5.7	0.87	.....	.....	.....	.....	15.6	4	0.7	15.6(c)	0	0	6	Morris Knowles	822
4	1.2	6.5	1.2	0	15	7.8	8	0.25	15	10	7	13	Randolph	827
														823
														824
5.3	2.6	12.3	1.8	0	35	5.2	19	1	20	75	60	12	Randolph	825
5.1	0.9	4.6	0.8	0	26	2	3	0.15	16	12	65	22	Randolph	826
						UN	DERG	ROUN	D WA	TER				
2.1	2.4	38	5.2	4.8	102	3.5	6.5	0.25	15	.....	.....	.....	U. S. G. S.	1000
3.9	1.7	103.4	2.1	1	145	7.7	82	1.4	13.7	5	11	121	Randolph	1001
0.8	0.6	79	3.2	7.2	115	14	44	0.05	4.5	.....	.....	.....	U. S. G. S.	1002
17	8.1	16	8.7	0	135	3.9	3.5	0.21	76	.....	.....	.....	U. S. G. S.	1003
5.2	2.1	13	1.6	2	43	4.8	10	0.35	21.6	10	12	37	Randolph	1004
81.8	14.4	280	2.3	0	122	28	531	1.1	260	15	20	104	Randolph	1005
18	15	63	2.8	1	143	5.6	90	0.4	107	30	30	120	Randolph	1006
28	3.8	52	3	0	150	19.6	40	0.5	86	35	40	125	Randolph	1007
11.8	8.7	27.2	1.9	0	127.5	8.2	8	8.3	65.3	20	15	106.3	Randolph	1008
0.5	0.6	59	3	4.8	141	5.4	4.4	0.25	3.7	.....	.....	.....	U. S. G. S.	1010
58	2.1	20.8	3.5	0	164	8.4	23	1	154	30	50	136	Randolph	1009

(bb) Analyses Oct. 2 to Nov. 27, 1906, by R. B. Dole; Nov. 28, 1906, to Apr. 6, 1907, by R. B. Dole and M. G. Roberts; pr. 8 to July 4, 1907, by Chase Palmer and M. G. Roberts; July 6 to Oct. 9, 1907, by R. B. Dole, Chase Palmer, and W. D ollins.

(c) Soap hardness instead of Calculated hardness.
(d) Acidity, five (5) parts per million.
(e) Fe_2O_3 plus Al_2O_3, 2.5. Loss on ignition, 6.0.

of North Carolina, Part I, The Physiography and Geology of the Coastal Plain of North Carolina; and Part II, The Water Resources of the Coastal Plain of North Carolina.

Considering our present day circumstances, it is probable that the most valuable sections of this volume are those on the "Sources of the Underground Waters", "Principles and Conditions Controlling the Storage and Circulation of Underground Waters of the N. C. Coastal Plain", and on the "Geologic Occurrence and Character of the Underground Waters". These sections are accompanied by a "Contour Map of the Buried Surface of the Basement Rocks Underlying the Deposits of the Coastal Plain", together with several maps showing the areas from which potable waters may be obtained from the various geologic formations. On the quality of the water, Vol. III, Part II, presents as Table I, the assays (incomplete analyses) of 188 samples of water from as many sources (wells and springs only), and as Table II, the mineral analyses of 58 samples from wells and springs. The volume was issued in 1912, but no analyses are reported for later than 1907.

TABLE 9—Analyses of Water from Pee Dee River Near Pee Dee, N. C.[a]

[Parts per Million]

Date (1906-7). From—	Date (1906-7). To—	Turbidity.	Total iron (Fe).	Silica (SiO_2).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium and potassium (Na+K).	Carbonate radicle (CO_3).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Nitrate radicle (NO_3).	Chlorine (Cl).	Total dissolved solids.	Mean gage height (feet).[b]
Oct. 26	Nov. 5	40	.....	39	Tr.	9.1	1.6	.....	0.0	34	.....	0.4	3.5	87	3.0
Nov. 6	16	90	.....	30	0.9	5.7	Tr.	.....	.0	20	.....	.6	2.0	62	2.8
17	29	140	.....	32	.9	4.7	Tr.	.....	.0	16	.....	.3	7.5	82	3.9
30	Dec. 11	135	.....	30	.8	5.5	Tr.	.....	.0	20	.....	.5	7.0	78	2.8
Dec. 12	21	140	.....	26	.8	6.4	1.2	.....	.0	22	.....	.6	7.5	74	3.1
27	Jan. 8	145	.....	30	.40	5.2	Tr.	.....	.0	17	.....	.6	4.0	72	3.8
Jan. 9	21	15	.....	25	.20	7.4	1.6	.....	.0	27	.....	.4	1.7	63	2.8
22	Feb. 3	25	.....	18	.30	8.4	1.6	.....	.0	32	.....	.9	3.0	58	2.6
Feb. 6	19	15	.....	13	.20	9.2	1.6	.....	.0	32	.....	.4	4.5	58	2.7
20	Mar. 15	40	.....	14	.10	12	0.8	.....	.0	41	.....	.4	1.5	64	3.2
Mar. 16	30	25	.....	18	.10	10	1.2	.....	.0	34	.....	.7	3.5	59	2.8
31	Apr. 15	20	.....	26	.30	7.6	Tr.	.....	.0	24	.....	.4	2.0	45	3.1
Apr. 16	25	120	.....	15	.20	7.0	1.2	.....	.0	24	.....	.2	2.0	45	3.1
26	May 1	160	.....	18	.40	5.5	1.2	.....	.0	20	.....	.3	3.0	40	3.4
May 2	11	100	.....	20	c1.4	6.5	2.9	7.2	.0	44	4.0	.5	3.0	76	2.9
12	21	60	.....	27	.40	6.7	3.3	7.8	.0	42	3.6	.2	3.5	78	2.5
22	June 3	255	.....	21	.8	5.1	2.1	11	.0	39	3.6	.4	4.5	74	2.8
June 18	28	365	.....	26	c2.8	4.1	3.7	7.2	.0	39	2.3	.5	3.0	86	3.0
29	July 10	375	.....	37	Tr.	5.1	1.3	14	.0	48	4.4	1.4	1.4	91	3.2
Aug. 19	Aug. 31	270	6.3	34	Tr.	5.8	0.8	13	.0	45	3.9	.9	1.6	86	2.4
Sept. 1	Sept. 13	240	10	23	.03	6.8	1.7	9.4	.0	44	3.9	.5	1.1	64	2.3
14	28	295	8.8	35	.03	4.9	1.3	5.4	.0	26	4.7	.7	.7	70	2.8
Oct. 2	Oct. 15	45	2.4	26	Tr.	6.6	.8	6.5	.0	29	3.9	.3	1.2	62	2.4
16	19	35	.....	30	Tr.	9.3	1.7	7.2	.0	43	5.6	1.1	1.1	78	2.2
Mean.	.....	131	.....	26	.31	6.9	1.3	8.9	.0	32	4.0	.6	3.1	69	.....

[a] Analyses Oct. 26, 1906, to May 1, 1907, by Jas. R. Evans; May 2, to June 28, 1907, by W. D. Collins; June 29, to Oct. 19, by R. B. Dole, Chase Palmer and W. D. Collins, all associated with the U. S. Geological Survey.

[b] Gaging station at Cheraw, S. C., 20 miles below.

[c] Abnormal; computed as HCO_3 in the average.

TABLE 10—Analyses of Water from Roanoke River at Randolph, Va.[a]

[Parts per Million]

Date (1906-7). From—	To—	Turbidity.	Total iron (Fe).	Silica (SiO_2).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium and potassium (Na+K).	Carbonate radicle (CO_3).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Nitrate radicle (NO_3).	Chlorine (Cl).	Total dissolved solids.
Sept 7	Sept. 16	500	14	25	2.5	10	4.4	6.5	0.0	57	3.6	0.5	2.4	102
17	26	300	14	24	1.5	8.8	2.8	6.9	.0	55	3.8	.3	2.6	90
27	Oct. 4	270	15	16	1.2	9.0	3.2	6.3	.0	48	4.0	Tr.	1.9	74
Oct 10	25	290	14	23	2.1	8.4	2.6	.....	.0	45	3.0	.7	1.9	84
26	Nov. 5	38	2.6	19	.4	11	4.4	6.6	.0	59	4.3	.5	2.2	76
Nov. 6	17	21	1.2	22	.3	11	4.4	7.4	.0	61	4.9	.6	2.5	80
18	27	350	15	23	1.3	8.8	3.8	7.2	.0	50	5.7	.9	1.9	82
Dec. 1	Dec. 15	17	1.4	29	.4	11	4.6	2.8	.0	61	4.4	.5	2.9	87
16	27	.....	7.7	20	1.0	9.2	3.8	3.9	.0	50	4.3	.4	2.6	75
28	Jan. 6	.....	7.3	19	1.6	8.8	3.6	5.4	.0	56	4.1	.9	2.3	72
Jan. 7	16	26	1.9	23	.6	9.4	3.8	2.5	.0	52	4.6	.6	2.4	69
17	26	23	2.1	25	.6	10	4.0	4.5	.0	54	4.6	.4	2.9	81
27	Feb. 5	26	2.3	18	.5	9.6	3.6	3.2	.0	51	4.1	.3	2.6	68
Feb. 6	Mar. 2	60	3.9	13	.5	9.4	2.8	4.4	.0	46	4.8	.3	2.2	62
Mar. 3	12	.....	7.7	25	1.0	8.8	3.2	7.2	.0	44	4.8	1.0	1.3	87
13	25	29	1.6	17	.19	8.4	2.6	7.1	b8.2	34	4.3	.0	1.7	65
26	Apr. 4	65	2.1	13	.32	9.8	3.0	7.6	.0	51	4.8	.2	2.0	64
Apr 5	14	171	6.5	24	1.0	9 6	3.2	7.6	.0	50	4.9	1.0	1.4	83
19	29	290	18	28	1.0	10	3.4	7.2	.0	55	5.1	1.0	2.2	91
30	May 12	400	16	22	1.0	9.6	3.2	8.5	.0	58	4.1	.5	2.6	85
Mean.	.....	169	7.7	21	.95	9.5	3.5	5.9	.0	53	4.4	.5	2.2	79

aAnalyses Sept. 7, to Nov. 27, 1906, by R. B. Dole; Dec. 1, 1906, to Apr. 4, 1907, by R. B. Dole and M. G. Roberts; Apr. 5, to May 12, 1907, by Chase Palmer and M. G. Roberts, all associated with the U. S. Geological Survey.

bAbnormal; computed as HCO_3 in the average.

TABLE 11—Analyses of Water from Cape Fear River at Wilmington, N. C.[a]

[Parts per Million]

Date (1906-7). From—	Date (1906-7). To—	Turbidity.	Total iron (Fe).	Silica (SiO_2).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium and potassium (Na+K).	Carbonate radicle (CO_3).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Nitrate radicle (NO_3).	Chlorine (Cl).	Total dissolved solids.	Mean gage height (feet).[b]
Oct. 2	Oct. 8	11	1.2	10	0.6	5.4	1.0	6.3	0.0	22	2.6	0.0	6.0	64	5.4
10	23	c16	c.9	c10	c.7	c7.2	c7.6	c67	c.0	c20	c12	c.0	c130	c247	c4.9
25	Nov. 5	11	.5	8.8	.5	4.8	1.0	6.6	.0	20	2.6	.0	6.2	65	4.8
Nov. 6	17	12	.6	10	.6	4.6	1.0	6.9	.0	22	2.3	.0	6.5	63	3.6
18	27	9	.5	10	.5	4.4	.8	5.7	.0	22	2.3	.0	6.0	59	4.0
28	Dec. 7	11	.4	11	.4	5.0	1.0	5.8	.0	22	2.8	.0	6.2	52	2.9
Dec. 8	17	14	.4	12	.5	5.6	1.2	7.6	.0	29	3.3	.2	6.1	61	4.7
18	30	19	.9	10	.4	4.6	1.6	6.5	.0	20	2.5	Tr.	.....	53	7.6
31	Jan. 9	11	.8	10	.54	5.0	1.0	6.9	.0	.....	3.1	.0	6.5	56	5.8
Jan. 10	20	17	.9	8.2	.37	5.0	.6	5.3	.0	22	2.3	Tr.	5.8	44	4.3
21	Feb. 1	11	.6	10	.4	4.8	1.0	6.8	.0	22	2.8	.0	4.6	52	4.1
Feb. 2	13	19	1.0	9.8	.53	4.8	1.0	5.6	.0	27	2.3	1.8	6.1	55	8.9
14	27	21	1.4	8.6	.61	3.8	.6	4.8	.0	18	2.5	Tr.	6.0	45	10.6
28	Mar. 14	29	1.5	7.6	.81	3.8	.6	4.9	.0	21	2.8	.3	5.0	47	13.7
Mar. 15	26	29	2.3	18	1.8	4.0	.8	6.4	.0	23	2.6	.0	4.6	65	11.3
27	Apr. 6	27	1.6	11	1.0	4.4	.8	.....	.0	22	2.8	.4	5.8	50	6.4
Apr. 8	18	42	2.3	.....	2.1	4.2	.6	.....	.....	.....	2.5	1.0	.....	.....	10.1
19	30	32	1.9	15	1.7	4.4	1.0	6.9	.0	22	2.6	.75	4.6	62	12.5
May 1	May 11	31	1.6	14	1.1	4.4	1.4	6.8	.0	24	1.6	.5	6.1	60	10.9
13	24	28	1.2	8.0	.35	4.2	1.0	7.7	0	20	2.0	.5	6.0	52	6.0
25	June 6	25	1.0	7.0	.28	4.6	.8	7.9	.0	22	1.6	.5	6.6	50	10.4
June 8	21	28	1.4	9.2	.75	4.2	1.0	9.0	.0	24	1.6	.5	6.2	58	10.9
24	July 4	32	1.8	7.2	.65	4.8	1.2	6.1	.0	26	2.0	.3	7.0	62	9.6
July 6	17	.....	1.2	2.6	.13	6.6	.6	11	.0	34	4.0	.0	4.8	48	5.4
19	Aug. 1	.....	1.4	7.6	.88	5.4	1.8	6.6	.0	26	5.4	Tr.	5.4	57	4.4
Aug. 2	12	.....	1.5	6.2	.61	6.4	.6	9.1	.0	29	6.9	Tr.	4.8	56	4.0
13	24	20	1.4	11	1.1	5.5	2.0	12	.0	41	5.8	Tr.	5.4	66	6.6
26	Sept. 5	20	1.4	8.8	.77	6.5	.8	5.7	.0	24	5.1	Tr.	5.0	61	5.8
Sept. 6	18	75	4.0	14	1.8	5.6	1.8	8.5	.0	28	5.3	.5	6.6	68	6.4
30	Oct. 9	15	1.4	11	.79	8.3	1.8	12	.0	39	5.6	Tr.	7.0	75	3.7
Mean.	.....	73	1.3	9.9	.78	5.0	1.5	7.2	.0	25	3.2	.2	5.8	57	.....

[a] Analyses Oct. 2, to Nov. 27, 1906, by R. B. Dole; Nov. 28, 1906, to Apr. 6, 1907, by R. B. Dole and M. G. Roberts; Apr. 8, to July 4, 1907, by Chase Palmer and M. G. Roberts; July 6, to Oct. 9, 1907, by R. B. Dole, Chase Palmer, and W. D. Collins, all associated with the U. S. Geological Survey.

[b] Gaging station near Fayetteville, N. C., 75 miles above

[c] Abnormal; omitted from the average.

TABLE 12

THE AVERAGE ANALYSIS OF A HYPOTHETICAL STREAM IN THE COASTAL PLAIN SECTION OF NORTH CAROLINA

	No. of Analyses Considered	Parts Per Million
Silica (SiO_2)	16	13.
Iron (Fe)	16	0.6
Calcium (Ca)	16	4.7
Magnesium (Mg)	16	1.9
Sodium (Na)	15	5.4
Potassium (K)	15	1.1
Carbonate radicle (CO_3)	26	0.
Bicarbonate radicle (HCO_3)	15	21.
Sulphate radicle (SO_4)	16	4.9
Chloride radicle (Cl)	17	7.8
Nitrate radicle (NO_3)	19	0.60
Total dissolved solids at 180° C.	17	57.
Total hardness as $CaCO_3$ (calc.)	15	19.
Color	14	34.
Turbidity	16	66.
Suspended matter	17	48.
Alkalinity	15	15.

OTHER ANALYSES

As the result of a letter sent out by Director Phillips to the several chambers of commerce in the State advising them of his plans for this publication, a number of miscellaneous analyses were received. Similar advice sent to superintendents of water works out in the State caused a number of others to be sent in. In some cases, it was possible to insert them in the main tables, but in others the determinations were not reported according to any standard form and these have been grouped in Table 14. Reference to these analyses has been made in the table in which they would have been placed ordinarily.

The Development Service of the Southern Railway System furnished twelve analyses which were originally reported in the combined form in terms of grains per gallon. At the request of the Department, the analyst, J. C. Ramage, Engineer of Tests, was kind enough to restate them in terms of parts per million in the radicle form, but they were received too late for inclusion in the proper tables. These analyses are reported in Table 13.

Attention is called to the fact that determinations of alkalinity in this table are reported as CO_3 instead of as the bicarbonate HCO_3 which is the practice in the other tables, following standard methods of the U. S. Geological Survey as mentioned on page 72.

COMPARISON OF NORTH CAROLINA UNTREATED SURFACE WATERS WITH THOSE OF OTHER STATES

Table 15 presents some comparative analyses. Numbers 1 to 3 inclusive are referred to in the text (Tables 3, 7 and 12,) and represent the average of all analyses from surface waters in the three principal sections of the State. No. 4 is an analysis of an average North Carolina water obtained by averaging all of the unfiltered surface water analyses reported in the tables. These analyses portray reasonably accurately what ordinary quantities of chemical elements may be expected in an average stream in the three sections of the State.

The analyses numbered 5 to 18 inclusive were selected at random from various publications available to the authors. They were confined to unfiltered surface supplies to make them comparable with the North Carolina analyses.

Hardness.—Collins[1] states that "hardness is by far the most important property of a water with reference to its general industrial utility". (See also page 69.) The remarkable freedom of North Carolina waters from ingredients causing hardness is well shown in column 11. All representations of waters from this State show markedly lower hardness than any from other states. In those analyses where hardness is not reported some idea of the relative hardness may be gained from the analyses of calcium and bicarbonates. The New York Catskill supply (No. 12) is the only water even approaching North Carolina waters in freedom from calcium. This water and that of the Monongahela (15) are the only ones showing nearly the freedom from bicarbonates as do those of North Carolina. In other words North Carolina waters are markedly superior to those from most other places east of the Mississippi in freedom from hardness.

Inspection of Table 15 will show North Carolina waters superior to most others in freedom from other chemical elements.

[1]Collins, W. D., The Industrial Utility of Public Water Supplies in the United States. Water Supply Paper 496. U. S. Geological Survey, Washington, 1923.

TABLE 13—Analyses of Surface Waters of North Carolina as Prepar
(Southern Railway Analyses by J.

Water Resources Number	NAME OF STREAM AND APPROXIMATE LOCATION OF SAMPLING POINT	County	Date of Collection	Suspended matter	Total dis'd solids	Organic matter	Silica (SiO_2)
				Analyses in parts per million			
171	Cathey's Creek, filtered; near Brevard, N. C.	Transylvania.....	Oct. 31, 1925....	0	.....	.....	5.
173	French Broad River, filtered; near Marshall, N. C.....	Madison.....	May 3, 1923....	34.3	68	.....	0.
177	Catawba River, near Morganton, N. C.....	Burke.....	July 25, 1925....	0	.....	2.58	13.
432	Third Creek, near Statesville, N. C.....	Iredell.....	Dec. 22, 1925...	57.63	.....	2.23	17.
433	Yadkin River, South Fork, filtered; near Statesville, N. C.....	Iredell.....	Dec. 22, 1925...	22.12	.....	3.43	9.
434	Snow Creek, Crossing of old road, Statesville to Wilksboro at a point about 12 miles from Statesville, N. C.....	Iredell.....	Dec. 22, 1925...	12	.....	2.75	12.
438	Yadkin River, Main Stream near Salisbury, N. C.....	Rowan.....	Mar. 28, 1925...	27.8	.....	8.74	5.
439	Yadkin River, North Fork, near Salisbury, N. C.....	Davie-Davidson...	Mar. 28, 1925...	66.9	.....	14.23	4.
441	Hogan Creek, near Reidsville, N. C.....	Rockingham.....	Jan. 14, 1926....	0	.....	3.43	18.
443	Haw River, filtered; near Burlington, N. C.	Alamance.....	Oct. 31, 1925....	30.9	.....	12.89	20
461	Yadkin River, near Salisbury, N. C.....	Rowan.....	Dec. 13, 1927...	0	.....	.....	7.

by the "Development Service" of the Southern Railway System (1)
Ramage, Engineer of Tests, Norfolk, Va.)

Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate radicle (CO_3)	Bicarbonate radicle (HCO_3)	Sulphate radicle (SO_4)	Chloride radicle (CL)	Nitrate radicle (NO_3)	Total	Total Hard'ss Cal'd ($CaCO_3$)	Turbidity	Alkalinity	Water Resources Number
Analyses in parts per million														
0.96	1.51	2.11	4.40	.....	7.53	.....	5.10	3.02	.....	30.46	12.5	.....	12.2	171
1.08	6.92	0.54	2.20	0.93	5.60	.....	11.90	2.68	TR	33.40	19.55	.....	9.3	173
0.36	3.2	0.98	3.89	.....	6.57	.....	3.9	3.9	.....	38.78	12	.....	10.9	177
2.40	4.81	3.73	3.25	.....	16.53	.....	1.98	3.55	.....	57.35	27.50	.....	27.50	432
1.80	3.98	2.24	3.11	.....	10.26	.....	2.05	4.79	.....	44.19	19.30	.....	17.10	433
1.32	3.98	2.55	2.85	.....	9.28	.....	6.10	3.54	.....	46.26	20.6	.....	15.4	434
0.59	4.90	2.41	4.72	.....	8.27	.....	14.01	3.01	.....	51.79	22.3	.....	13.7	438
0.72	5.65	2.62	5.16	.....	10.71	.....	13.33	3.32	.....	60.71	25	.....	17.8	439
0.60	3.17	3.67	4.30	.....	13.10	.....	3.53	5.00	.....	56.73	23.5	.....	21.8	441
4.56	7.55	5.10	13.56	.....	24.1	.....	11.13	12.70	.....	111.59	30	.....	40.1	443
0.47	12.7	1.46	2.70	.....	2.81	.....	30.23	3	1.25	62.33	37.75	.....	4.67	461

TABLE 14—Analyses of Surface Waters of No

(A Table of Mi

(The analyses presented in this table, reported individually by the se form and they are herewith presented in a Miscellaneous Table. See f

Water Resources Number	NAME OF STREAM AND APPROXIMATE LOCATION OF SAMPLING POINT	County	Date	Suspended Matter	Total Dissolved Solids	Silica (SiO_2)	(a) Fe (b) Fe_2O_3	
			Analyses in parts per million.					
176	Wilson Creek, Mortimer, N. C.....	Caldwell.....	.....	.....	56.77	1.2	(b) 1.2	..
429	Municipal Intake, Gastonia, N. C.....	Gaston.....	Nov. 13, 1925...	20	67.2	16	(b) 1.7	(b
430	Municipal Supply (filtered) Gastonia, N.C..	Gaston.....	Nov. 13. 1925...	0	46.8	4	(b) 0.6	(b
431	Charlotte Municipal, Catawba River (filtered) (2).....	Mecklenburg..	Oct. 27, 1925....	.....	33.5	9.3	(b) 0.4	(a
442	Greensboro Impounded Supply, Horsepen & Reedy Fork Creeks.....	Guilford.....	June 14, 1926...	0	.....	8.77	.....	(a
437	Yadkin River, near Salisbury.....	Rowan.....	.....	.....	.....	7.7	(b) .67	(a
823	Temple Creek, near Sanford, N.C. (4).....	Lee.....	Dec. —, 1925...	.....	6.61	0.73	(p) 0.25	(a
824	Teague & Johnson Creek, South of Sanford, N. C. (4).....	Lee.....	Dec. —, 1924...	.....	5.29	0.55	(p) 0.35	(a

(1) As a result of notices sent out to superintendents of Water Works and Secretaries of Chambers of Commerce, a nu of analyses were received, and insofar as possible, they have been included in the bulletin. Those that could not be includ the regular tables, aside from those reported by Ramage of the Southern Railway, are given in this table. They are prese for what they may be worth, with apologies to the original analysts who could not be given an opportunity to check the fi as here given. In the event that any of these analyses prove to be of particular interest, it is suggested that a request be of the Water Resources Division for copies of the report as originally received.

(2) Original determinations in addition to values given, were as follows: Lime (CaO)-2.7, Magnesia (MgO)-1.9, So Oxide (Na_2O)-2.2, Sulphur Trioxide (SO_3)-0.9, Chlorine (Cl)-3.2.

(3) H. H. Craver, Manager Chemical Department, Pittsburgh Testing Laboratories, Pittsburgh, Pa.

(4) These samples were analyzed for the Seaboard Air Line Railway Company, Savannah, Ga.

(m) Alkalinity as $CaCO_3$.

(n) Average Values.

(p) Reported as Fe plus Al_2O_3.

* Practically all of these analyses were originally made and reported in terms of grains per gallon. The conversion terms of parts per million was made in the Water Resources Division Office without the subsequent check of the analyst

Carolina as Reported from Different Laboratories (1)

llaneous Analyses)

al different analysts, could not be grouped with those reported in the radicle notes and other details as presented).

Analyses in parts per million.

Calcium Sulphate ($CaSO_4$)	Magnesium Carbonate ($MgCO_3$)	(a) NaCl (b) Na_2SO_4	Sulphate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Other	Hardness (a) Calc'd (b) Soap	Color	Turbidity	Alkalinity	Authority	Water Resources Number
.....	.....	.....	4.62	10.94	0	Residue-45.14... Ammonia-.005...	.....	.....	.....	.....	F. C. Vilbrandt	176
.....	.....	.....	.....	5.6	....	MgO-0.8..... Alumina-1.2....	(b)14	60	.....	24 (m)	H. H. Craver (3)	429
.....	.....	.....	.....	8	....	MgO-2..... Alumina-0.6....	(b) 4	10	.....	2 (m)	H. H. Craver (3)	430
1.4	3.9	(a) 5.3..... (b) 0.2.....	.....	.....	....	Al_2O_3-0.6.....	(b) 19	6	0	14	E. G. McConnell	431
12.66	16.64	(a)+KCl_2.. 17.4 (b)+K_2SO_4 4.34	.....	.....	....	Al_2O_3-1.2..... $NaNO_2$+KNO_2 Tr.	(a) 30 (n)	0 (n)	0 (n)	24 (n)	Dearborn Chem. Co.	442
38.8	1.2	(a) 4.9.....	.....	.....	....	Total Solid Residue 66.7....	.....	.....	.....	.....	Ramage	437
.....	.....	(b) 0.41....	.....	.....	....	$MgSO_4$-.22	.....	.....	.....	.....	Norfolk Testing Laboratories	823
.....	0.3	(a) 1.91.... (a) 0.76.... (b) 0.35....	.....	.....	....	.....	.....	.....	.....	.....	Norfolk Testing Laboratories	824

TABLE 15—Comparative Analyses

No.	DESCRIPTION
	AVERAGE OF NORTH CAROLINA ANALYSES
1	**Average analysis of a hypothetical stream in Mountain Section of North Carolina. Made by averaging about 74 separate analyses, as shown in Table 2.**
2	**Average analysis of a hypothetical stream in Piedmont Section of North Carolina. Made by averaging about 35 separate analyses, as shown in Table 4.**
3	**Average analysis of a hypothetical stream in Coastal Plain Section of North Carolina. Made by averaging about 16 separate analyses, as shown in Table 8.**
4	**Average analysis of a hypothetical stream in North Carolina. Made by averaging about 125 separate analyses from samples from all parts of state. Essentially a weighted average of the analyses Nos. 1, 2, and 3 above.**
	REPRESENTATIVE ANALYSES OF SEVERAL IMPORTANT INDUSTRIAL SUPPLIES.
5	Chicago, Ill. Municipal supply, from Lake Michigan. Analysis Feb. 1916 by Ill. State Water Survey. Reported in U. S. Geol. Survey Water Supply paper 496.
6	Detroit, Mich. Municipal Supply, from Detroit River. Analysis by W. M. Wallace. July 1921. Reported in U. S. Geol. Water Supply Paper 496.
7	Mississippi River in Missouri. Average of 10 samples from different points. Reported in "Water Resources of Missouri, 1859–1926" by Mo. Bur. of Geol. and Mines. Analyses for 1926.
8	Missouri River in Missouri. Average of 19 samples from different points. Reported in "Water Resources of Missouri. 1859–1926" by Mo. Bur. of Geol. and Mines. Analyses for 1926.
9	Jersey City, N. J. Municipal Supply from Boonton Reservoir. Analysis by M. D. Foster, Feb. 1922. Reported in U. S. Geol. Survey Water Supply Paper 496.
10	Buffalo, N. Y. Municipal Supply. Lake Erie. Composite of samples during 1906–07. Reported in U. S. Geol. Survey. Professional Paper 135.
11	Hudson River at Hudson, N. Y. Analysis averaged from 36 analyses during 1906–07. Reported in U. S. Geol. Survey. Professional Paper 135.
12	New York City. Municipal Supply from Catskill Sources. Reported by U. S. Geol. Survey in Water Supply Paper 496.
13	Dayton, Ohio. Miami River. Average of 8 samples during 1901, by State Bd. of Health. Reported in "Industrial Water Supplies of Ohio" State Geol. Survey, 1925.
14	Columbus, Ohio. Scioto River. Average of 6 samples during 1897, by State Bd. of Health. Reported in "Industrial Water Supplies of Ohio" State Geol. Survey, 1925.
15	Elizabeth, Pa. Monongahela River. Average of 37 analyses of samples during 1906–07. Reported in U. S. Geol. Survey Professional Paper 135.
16	Williamsport, Pa. Susquehanna River. Average of 36 analyses of samples collected during 1906–07. Reported in U. S. Geol. Survey Professional Paper 135.
17	Nashville, Tenn. Cumberland River. Average of 35 analyses of samples collected in 1906–07. Reported in U. S. Geol. Survey Professional Paper 135.
18	Knoxville, Tenn. Tennessee River. Average of 32 analyses of samples collected in 1906–07. Reported in U. S. Geol. Survey Professional Paper 135.

of Surface Waters in Various States

CHEMICAL CONSTITUENTS—PARTS PER MILLION

Silica SiO_2	Iron Fe	Calcium Ca	Magnesium Mg	Sodium and Potassium Na and K	Bicarbonate HCO_3	Sulphate SO_4	Chloride Cl	Nitrate NO_3	Total Dissolved Solids	Total Hardness as $CaCO_3$	Color	Turbidity	Suspended Matter	Alkalinity	No.
AVERAGE OF NORTH CAROLINA ANALYSES															
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	
10	0.21	2.4	1	2.78	12	2.4	1.9	0.33	31	10	14	34	11	11	1
16	†0.81	5.2	1.9	5.18	21	5.9	4.6	0.83	62	20	31	102	61	18	2
13	0.6	4.7	1.9	6.5	21	4.9	7.8	0.60	57	19	34	66	48	15	3
12	0.43	3.5	1.4	3.95	16	3.8	3.5	0.51	43	14	21	60	30	14	4
REPRESENTATIVE ANALYSES OF SEVERAL IMPORTANT INDUSTRIAL SUPPLIES															
18	0.4	36	10	6.2	144	10	6	1.8	183	131	.....	.....	.....	.....	5
1	0.2	27	7	2	102	7.4	4.5	0.08	99	96	.....	.....	.....	.....	6
8.1	0.59	38.3	12.1	20.2	133	53.2	7.9	1.55	209*	145	.....	.....	1509	114	7
11.7	0.71	46.2	10.6	39.2	148	81.8	18.8	0.88	285*	159	.....	.....	1845	127	8
6.5	0.08	13	5.6	4.6	40	22	5.1	1.1	81	55	.....	.....	.....	.....	9
5.9	0.07	31	7.6	6.5	120	13	8.7	0.3	133	109	.....	.....	.....	.....	10
11	0.15	21	3.8	7.9	73	16	4.0	0.8	108	.....	.....	13	.....	.....	11
2.6	0.04	4.5	1.2	1.7	11	7.4	1.0	0.49	28	16	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	1.5	Tr.	.....	245.8	.25	.25	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	7.2	4.9	.....	263	.6	Mkd.	.....	.....	14
8.4	0.49	12	2.2	7.3	18	33	3.2	1.8	81	.....	.....	82	.....	.....	15
7.6	0.11	12	3.4	6.0	28	26	4.0	0.7	74	.....	.....	10	.....	.....	16
20	0.42	26	3.6	9.6	92	14	2.1	1.2	119	.....	.....	126	.....	.....	17
25	0.54	22	4.3	8.2	86	6.4	9.6	0.8	122	.....	.....	204	156	.....	18

*Reported as "sum of constituents."

†0.81 as average value for Fe in Piedmont waters results from inclusion of one or two analyses unusually high in iron and is therefore misleading. See Tables 4 and 5.

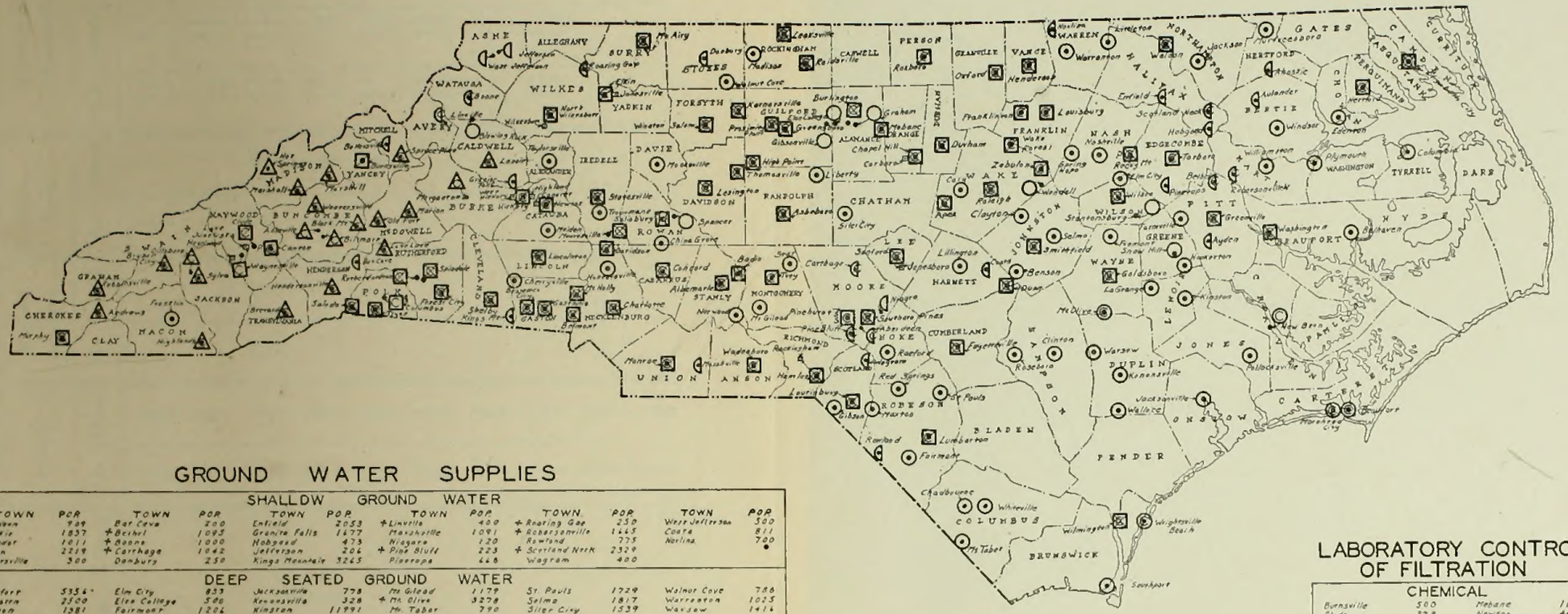
This relative purity of North Carolina waters can best be summarized by a study of column 10, "total dissolved solids". Again the Catskill water of New York is the only water to approach the excellence of those in North Carolina.

PUBLIC WATER SUPPLIES OF NORTH CAROLINA

It has not been possible to include detailed information in this publication relative to the public water supplies of the State. However, through the courtesy of the North Carolina State Board of Health, there is presented as Plate III a map prepared by its Bureau of Sanitary Engineering and Inspection which presents information in great detail as to the location of the supplies now developed for serving the various municipalities and communities, the nature of the source, the character of the treatment provided, etc. Mr. H. E. Miller, Director of the Bureau of Sanitary Engineering and Inspection, has also compiled the data in Table 16 which gives much valuable information as to the chemical quality of the water provided by typical filter plants in a number of communities in the State. Table 17, also compiled under Mr. Miller's direction, gives additional information relative to municipal water systems. These two tables refer only to systems utilizing surface sources.

THE PUBLIC WATER SUPPLIES OF NORTH CAROLINA

JANUARY - 1928



GROUND WATER SUPPLIES

SHALLOW GROUND WATER

TOWN	POP	TOWN	POP	TOWN	POP	TOWN	POP	TOWN	POP	TOWN	POP
+Abingdon	909	Bat Cave	200	Enfield	2053	+Linville	400	+ Roaring Gap	250	West Jefferson	500
Ahoskie	1837	+ Bethel	1095	Granite Falls	1677	Marshville	1091	+ Roarsonville	1445	Cleta	811
Ashevat	1811	+ Boone	1000	Hobgood	473	Niagara	120	Rowland	775	Norlina	700
Ayden	2219	+ Carthage	1042	Jefferson	206	+ Pilot Bluff	223	+ Scotland Neck	2329		
Barnesville	300	Danbury	250	Kings Mountain	3263	Pleasrops	468	Wagram	400		

DEEP SEATED GROUND WATER

+Beaufort	5356*	Elm City	853	Jacksonville	778	Mt Gilead	1179	St Pauls	1729	Walnut Cove	788
Belhaven	2500	Elon College	580	Kenansville	328	+ Mt Olive	3278	Selma	1817	Warrenton	1025
Bonsep	1381	Fairmont	1204	Kinston	11991	Mt Tabor	390	Siler City	1539	Warsaw	1414
Blowing Rock	758	Farmville	2558	La Grange	1713	Murfreesboro	430	Snow Hill	900	Wendell	1622
Cary	855	Franklin	1088	Liberty	745	Nashville	1290	Southport	1808	Whiteville	1901
Creedmore	1200	Fremont	1568	Lillington	763	+ New Bern	13988	Spencer	2984	Williamston	1981
Cherryville	2470	Gibson	295	Littleton	1025	Norwood	1455	Spring Hope	1225	Windsor	1631
China Grove	1137	Gibsonville	1414	Madison	1419	Plymouth	1900	Spencer	600	+ Wightsville Beach	1800
Clayton	1568	Graham	2500	Marion	1748	Pittsboro	429	Star	649		
Clinton	4910	Hookerton	564	Marion	1438	Rutherford	1759	Taylorsville	1490		
Columbia	750	Hurtersville	1024	Mocksville	1212	Red Springs	1050	Troutman	432		
Edenton	2800	Jackson	621	+ Roxhood City	3493	Roseboro	1201	Wallace	908		

+ CHLORINATED

SURFACE WATER SUPPLIES

UNFILTERED STERILIZED LIQUID CHLORINE

Andrews	2194	Brevard	2252	Highlands	350	Marion	1996	Old Fort	1053	Weaverville.	737
Asheville	34284	Bryson City	1098	• Hot Springs	337	Marshall	750	Robbinsville	121		
Biltmore	1500	Dillsboro	250	Lake Lure	250	Mars Hill	414	Spruce Pine	1000		
Black Mountain	1300	Hendersonville	4442	Lenoir	4000	Morganton	2971	Sylva	895	□ Not Chlorinated	

FILTERED STERILIZED LIQUID CHLORINE

Albemarle	3151	• Conover	889	• Hazelwood	529	Lumberton	3060	Roxboro	1832	Wake Forest	2000
Apex	1122	Davidson	1736	Henderson	5797	Mebane	1877	Rutherfordton	2197	Washington	4395
Asheboro	3114	Dunn	3591	Hertford	1730	Mooresville	5067	+ Salisbury	19265	Waynesville	2500
+ Badin	5000	Durham	13900	Hickory	4114	Monroe	• 985	Saluda	800	Weldon	1900
Belmont	4358	Elizabeth City	9336	• Highland	1522	Mt Airy	5478	Sanford	3530	• West Hickory	16402
Brasmer City	2494	Elkin	1442	High Point	25000	Mt Holly	1447	Shelby	3994	• Wilkesboro	824
Burlington	6867	Fayetteville	10342	• Jonesboro	956	Murphy	1586	Smithfield	2353	Wilmington	39472
Burnsville	300	Forest City	2885	• Jonesville	928	Newton	3585	Sou. Pines	905	Wilson	13802
Caston	3237	Franklinton	2257	Kernersville	1292	N. Wilksboro	2732	Spindale	2300	Winston-Salem	71800
• Calboro	1500	Gastonia	18853	• Lost Junction	*2850	Oxford	4076	Statesville	10533	Zebulon	1329
Chapel Hill	4250	Goldsboro	15451	Louisburg	2900	Pinehurst	2200	Tarboro	5081		
Charlotte	80400	Greensboro	48784	Lexington	6127	Raleigh	31800	Thomasville	7276		
Clyde	378	Piedmont Plant		Lincolnton	4171	• Reidsville	5737	Troy	1150		
Columbus	205	Pineville	708	Louisburg	2098	• Rockingham	2792	Tryon	1560		
Concord	10854	Hamlet	5114	Louisburg	2098	Rocky Mount	16432	Waxhaw	2865		

+ STERILIZED WITH HYPOCHLORITE
• SUPPLIED BY ADJOINING TOWN

LEGEND

- Shallow Ground Supply
- Deep Seated Ground Supply
- Surface Supply - Gravity Filters
- P Surface Supply - Pressure Filters
- S Surface Supply - Slow Sand Filters
- Surface Supply - Unfiltered
- C Sterilized - Liquid Chlorine
- H Sterilized - Hypochlorite
- Chemical Control of Filtration
- Bacteriological Control of Filtration

RECAPITULATION

TYPE OF SUPPLY	Number Supplies	Per Cent Total Number Supplies	Population Served	Percentage Total State Population Served	Percentage Consumers Public Water Supply Served
Shallow Ground	26	137	27249	0.94	3.12
Deep Seated Ground	68	358	118571	4.10	13.64
Unfiltered Surface	21	111	64724	2.23	7.44
Filtered Surface	75	394	659596	22.78	75.80
Totals	190	1000	870141	30.05	100.00
Shallow Ground, Chlorinated	9	474	9990	0.31	1.41
Deep Seated Ground, Chlorinated	5	263	25515	0.87	2.91
Unfiltered Surface, Chlorinated	20	1005	66187	2.21	7.57
Filtered Surface, Chlorinated	75	3950	659596	22.77	75.80
Chemical Control-Filtration	17	895	44424	1.53	5.07
Chem & Bact Control-Filtration	54	2842	661720	22.84	75.80

LABORATORY CONTROL OF FILTRATION

CHEMICAL

Burnsville	500	Mebane	1877
Clyde	378	Newton	4474
Davidson	1736	Pinehurst	1892
Elkin	2342	Rutherfordton	2197
Franklinton	2257	Tarboro	5081
Hertford	1750	Troy	1150
Hickory	9288	Wadesboro	2865
Louisburg	2098	Zebulon	1329
Lumberton	3060		

CHEMICAL AND BACTERILDGICAL

Albemarle	3157	Lincolnton	4171
Apex	1122	Mooresville	5067
Asheboro	3114	Monroe	4085
Badin	3000	Mt Airy	5478
Belmont	4358	Mt Holly	1447
Brasmer City	2494	Murphy	1584
Burlington	6867	N. Wilksboro	3558
Chapel Hill	5750	Oxford	4076
Charlotte	80400	Raleigh	31000
Concord	10854	Reidsville	5737
Dunn	3591	Rocky Mt	16432
Durham	43900	Salisbury	19265
Elizabeth City	9336	Saluda	800
Fayetteville	10342	Sanford	4486
Forest City	2885	Shelby	3994
Gastonia	18853	Smithfield	2353
Goldsboro	15451	Southern Pines	905
Greensboro	48700	Spindale	2300
Piedmont Plant		Statesville	10533
Greenville	7108	Thomasville	7276
Hamlet	5114	Tryon	1560
Henderson	5797	Wake Forest	2000
High Point	25000	Washington	6395
Kernersville	1292	Weldon	1900
Laurinburg	2900	Wilmington	39472
Leaksville	1893	Wilson	13802
Lexington	6127	Winston Salem	71800

BUREAU OF SANITARY ENGINEERING AND INSPECTION

NORTH CAROLINA STATE BOARD OF HEALTH

TABLE 16—Operation Data on Representative North Carolina Water Purification Plants as Compiled from Monthly Reports of Plant Operators to the North Carolina State Board of Health in 1926

[Chemical Results Parts per Million]

Town / County / Source of Supply		Turbidty		Color		Alkalinity		Hardness or Incrustation		Carbon Dioxide		Hydrogen Ion Concentration		
		Raw	Filtered	Raw	Filtered	Raw	Filtered	Raw	Filtered	Raw	Filtered	Raw	Filtered	Tap
Belmont Processing Co.	Average..	246	0	.....	.....	18	12	.....	.....	2	4	7.5	6.6	.....
Gaston	Max.....	3000	0	.....	.....	24	22	.....	.....	3	6	7.6	7	.....
Catawba River	Min.....	15	0	.....	.....	12	6	.....	.....	2	1	6.8	4.6	.....
Chapel Hill	Average..	161	0	.....	.....	25	21	.....	.....	.....	.....	7.1	6.8	.....
Orange	Max.....	4000	0	.....	.....	38	35	.....	.....	.....	.....	7.6	7.1	.....
Morgans Creek	Min.....	20	0	.....	.....	11	7	.....	.....	.....	.....	6.4	6.4	.....
Charlotte	Average..	141	.....	.....	.....	15.3	12.2	16	18	2.2	4.2	7.2	6.7	.....
Mecklenburg	Max.....	500	.....	.....	.....	20	17	26	31	4	7	7.6	6.8	.....
Catawba River	Min.....	15	.....	.....	.....	10	8	10	7	1	2	6.8	6.5	.....
Cramerton	Average..	528	.....	23	.....	28	16	.....	.....	2	7	7.4	6.5	.....
Gaston	Max.....	7000	.....	40	.....	48	38	.....	.....	5	14	7.8	6.8	.....
.....	Min.....	12	.....	20	.....	14	0	.....	.....	0	4	6.4	6.2	.....
Forest City	Average..	121	0	.....	.....	12	10	.....	.....	3	4	6.5	6.3	.....
Rutherford	Max.....	1000	0	.....	.....	16	13	.....	.....	4	5	7	6.7	.....
Mill Creek	Min.....	30	0	.....	.....	6	7	.....	.....	2	3	6	6.1	.....
Gastonia	Average..	15.4	.....	.....	.....	20.3	15.4	.....	.....	.....	.....	7.3	6.6	.....
Gaston	Max.....	70	.....	.....	.....	27	24	.....	.....	.....	.....	8.4	6.8	.....
Long Creek	Min.....	5	.....	.....	.....	10	8	.....	.....	.....	.....	6.6	6.4	.....
Greenville	Average..	149	.....	.....	.....	3.9	7.2	.....	.....	.....	.....	.....	.....	.....
Pitt	Max.....	550	.....	.....	.....	6	10	.....	.....	.....	.....	.....	.....	.....
Tar River	Min.....	50	.....	.....	.....	3	5	.....	.....	.....	.....	.....	.....	.....
Henderson	Average..	56	.....	.....	.....	9	7	.....	.....	3	8	6.8	6	.....
Vance	Max.....	800	.....	.....	.....	13	24	.....	.....	12	26	8.2	6.3	.....
Sandy Creek	Min.....	5	.....	.....	.....	5	2	.....	.....	0	2	5.6	5.6	.....
Hickory	Average..	88	.....	.....	.....	8	7	.....	.....	.....	.....	.....	.....	.....
Catawba	Max.....	1000	.....	.....	.....	10	12	.....	.....	.....	.....	.....	.....	.....
Henrys Fork River	Min.....	9	.....	.....	.....	5	5	.....	.....	.....	.....	.....	.....	.....
Mebane	Average..	80.8	.....	.....	.....	21	22	.....	.....	.....	.....	.....	.....	.....
Alamance	Max.....	600	.....	.....	.....	38	40	.....	.....	.....	.....	.....	.....	.....
Mill Creek	Min.....	30	.....	.....	.....	14	12	.....	.....	.....	.....	.....	.....	.....

TABLE 16—Continued

Town / County / Source of Supply		Turbidty		Color		Alkalinity		Hardness or Incrustation		Carbon Dioxide		Hydrogen Ion Concentration		
		Raw	Filtered	Raw	Filtered	Raw	Filtered	Raw	Filtered	Raw	Filtered	Raw	Filtered	Tap
Mount Airy	Average	53	4.2	.....	.....	15	14.5	.....	.....	.....	4.5	6.6	.....	.....
Surry	Max	600	400	.....	.....	26	20	.....	.....	.....	12	7.2	.....	.....
Lovels Creek	Min	7	0	.....	.....	4	7	.....	.....	.....	1	6	.....	.....
Mount Holly	Average	106	0	.....	.....	17	16	.....	.....	2.5	2	6.8	6.4	.....
Gaston	Max	200	0	.....	.....	19	19	.....	.....	5	5	7.2	6.6	.....
Catawba River	Min	5	0	.....	.....	10	6	.....	.....	1	1	6.6	6.3	.....
Oxford	Average	118	0	.....	.....	18	15	.....	.....	7	9	6.6	6.3	.....
Granville	Max	2000	10	.....	.....	38	32	.....	.....	19	17	7	6.6	.....
Tar River	Min	15	0	.....	.....	4	5	.....	.....	3	3	6.2	6.0	.....
Proximity Mfg. Co., Greensboro	Average	.....	.....	61.2	5.2	25.3	21.4	.....	.....	.....	4.6	7.4	6.8	.....
Guilford	Max	.....	.....	175	20	38	32	.....	.....	.....	9.7	7.8	7.2	.....
Buffalo Lake	Min	.....	.....	5	2	18	12	.....	.....	.....	0.9	6.9	5.9	.....
Raleigh	Average	48	0	.....	.....	15.7	10.4	.....	.....	3.5	5.6	6.9	6.4	6.4
Wake	Max	400	2	.....	.....	22	17	.....	.....	9	13	7.5	6.4	6.6
Walnut Creek	Min	5	0	.....	.....	6	4	.....	.....	1	1	6.3	6.3	6.1
Rutherfordton	Average	30.4	.....	.....	.....	20.8	21.8	.....	.....	12	11	6.3	6.4	.....
Rutherford	Max	100	.....	.....	.....	25	31	.....	.....	24	20	6.6	6.5	.....
Hollands Creek	Min	0	.....	.....	.....	16	17	.....	.....	8	8	6	6.3	.....
Sanitorium	Average	.....	.....	75	9	3	10	.....	.....	10	11	6.2	5.6	.....
Hoke	Max	.....	.....	102	16	5	20	.....	.....	13	17	6.4	5.8	.....
Mountain Creek	Min	.....	.....	39	9	2	4	.....	.....	6	6	6	5.4	.....
Southern Pines	Average	.....	.....	59.7	4.8	4.2	6	.....	.....	4.3	3.8	5.9	6	.....
Moore	Max	.....	.....	152	42	11	13	.....	.....	20	26	6.8	7	.....
Springs	Min	.....	.....	21	0	0	1.5	.....	.....	0	0	5.2	5.4	.....
Statesville	Average	101	0	.....	.....	.....	16.1	.....	.....	.....	.....	.....	.....	6.7
Iredell	Max	2000	5	.....	.....	.....	22	.....	.....	.....	.....	.....	.....	7.2
N. Fork Fourth Creek	Min	20	0	.....	.....	.....	8	.....	.....	.....	.....	.....	.....	6.3
Troy	Average	22.4	5.3	.....	.....	.....	.....	.....	.....	6.9	6.8	6.6	6.5	.....
Montgomery	Max	40	10	.....	.....	.....	.....	.....	.....	13	10	7.2	6.8	.....
Denson Creek	Min	5	5	.....	.....	.....	.....	.....	.....	3	4	6	5.1	.....

TABLE 16—Continued

Weldon	Average..	.....	.....	.....	.....	26.4	17.6	.....	.....	2.8	5.1	.....	.....	.....
Halifax	Max.....	.....	.....	.....	.....	45	34	.....	.....	14	12	.....	.....	.....
Roanoke River	Min.....	.....	.....	.....	.....	6	7	.....	.....	1	2	.....	.....	.....
Wilmington	Average..	68	1	41	6	10	14	28	41	5	2	5.5	.....	6.9
New Hanover	Max.....	3000	10	90	30	17	33	75	84	10	6	6	.....	.....
Cape Fear River	Min.....	5	0	20	0	3	3	14	25	3	0	4.8	.....	6.2
Wilson	Average..	67	.....	.....	.....	6.9	5.8	.....	.....	.....	.....	6.3	5.7	.....
Wilson	Max.....	350	.....	.....	.....	13	11	.....	.....	.....	.....	7.6	6.3	.....
Contentnea Creek	Min.....	8	.....	.....	.....	3	3	.....	.....	.....	.....	4.4	5.4	.....

TABLE 17—Public Water Supplies of North Carolina from Surface Sources

(Data Furnished by N. C. State Board of Health)

Municipality or Institution	Source of Supply	Drainage Area Square Miles	Capacity of Filter Plant M. G. D.	Raw Water Pipe Line Size	Estimated Present Consumption M. G. D.	Capacity Clear Water Storage Million Gallons
Albemarle	Long Creek	35	1.5		0.044	0.460
Andrews	Beaver Creek	1.0		8″		0.100
Apex	William Creek		0.720		0.026	0.059
Asheboro	Long Branch	1.25	1.00			0.400
Asheville	Bee Tree Creek	5.8				
	North Fork Creek	22				5.350
Belmont						
Bessemer City	Long Creek	4.00	0.5		0.145	0.300
Black Mountain	Rocky Branch		0.300	6″		0.250
Brevard	Two branches of King's Creek, 2½ mi. from town	1.88		10″–8″–6″		0.125
Bryson City	Jenkins Branch, 4 mi. S. W. of town	0.39		6″		0.005
Burlington	Stoney Creek		3.0			0.600
Burnsville	Willie's Shanty Branch		0.5		0.098	0.200
Canton	Mountain Stream		1.0			0.750
Carboro	Water obtained from Chapel Hill, N. C. Supply					
Chapel Hill	Morgan's Creek	29 ‡	1.0		0.361	0.380
Charlotte	Catawba River	1805 ‡	8.5		5.615	4.750
Chimney Rock						
Clyde	Small Creek Tributary to Pigeon River	*1.60	0.25			0.053
Columbus	Horse Creek	*.520	0.08			0.075
Concord	Cold Water Creek	20.00	1.5			0.650
Conover	From Newton Supply.					
Cullowhee	Long Branch	0.44		4″–6″		0.143
Davidson			0.5		0.123	0.373
Dillsboro	Mountain Stream					0.100
Dunn	Cape Fear River		3.0			1.500
Durham	Flat River	165 ‡	9.5			3.500
Elizabeth City	Knobbs Creek		2.0		0.647	0.607
Elkin	Big Elkin Creek	*36.26	0.85			0.160
Fayetteville	Little Cross Creek	*10.00	2.0			0.370
Forest City	Mill Creek	*3.58	1.25		0.186	0.350
Franklinton	Sally Kearney Creek	*1.1	0.5			0.230
Gastonia	Long Creek	16 ‡	1.5		1.658	1.085
Goldsboro	Little River		2.5		0.999	0.710
Greensboro	Reedy Fork Creek	70	6.0			3.700
Proximity Mfg. Co.	Buffalo Lake	2.25	2.0		0.763	0.950
Greenville	Tar River	2678 ‡	1.5		0.499	1.000
Hamlet	Marks Creek	1.98	1.5			0.450
Hazelwood	From Waynesville Supply.					
Henderson	Sandy Creek	*0.94	2.0		0.886	0.920
Hendersonville	Fletcher Cr and Big Cr., Bradley Creek			18″	1.200	5.000
Hertford	Perquimans River	72.0	0.25			0.100
Hickory	Henry's Fork River	90.8	1.00		0.350	0.315
Highlands	Houston Branch			6″		
High Point	Deep River	55	6.00		2.193	3.400
Hot Springs	Spr. Creek-Cascade Br			2″–4″		0.100
Jonesboro	From Sanford Supply.					
Jonesville	From Elkin Supply.					
Kernersville	Middle Fork Cr., 2½ mi. above inters. of Smith Cr	0.5	1.0		0.114	0.500
Lake Junaluska	From Waynesville Supply.					
Laurinburg	Jordan's Creek		1.00			0.600
Leaksville	Dan River		0.5		0.088	0.656
Lenoir	Marrow Creeks	10 ‡		8″	0.200	0.500
Lexington	Abbott's Creek	60.0	3.0		0.592	1.550
Lincolnton	Walker Branch	*4.3	(Wells) 0.75		0.482	0.375
Louisburg	Tar River		1.0		0.312	1.636
Lumberton	Lumber River		1.0			0.550
Marion	Clear Creek	1.4		6″	0.250	1.350

*Area taken from Watershed maps. Other areas taken from old data, but not checked. All areas given in square miles unless marked otherwise.

‡From records of Water Resources Division, N. C., Dept. of Conservation and Development.

TABLE 17—Continued

Municipality or Institution	Source of Supply	Drainage Area Square Miles	Capacity of Filter Plant M. G. D.	Raw Water Pipe Line Size	Estimated Present Consumption M. G. D.	Capacity Clear Water Storage Million Gallons
Mars Hill	Head of Laurel R., East of Haw Mountain	0.84	0.49	6″	.....	0.150
Marshall	Walnut Cr., West Prong 1½ mi. above intersection	0.105	.....	6″	.....	0.150
Mebane	Mill Creek	9.8	0.25	.....	0.116	0.325
Monroe	Richardson's Cr., Lee's Mill	50 ‡	2.333	.....	0.367	0.945
Mooresville	Byers Creek	.....	0.72	.....	.....	0.700
Morganton	Henry Cr. and Henry Fork Cr.	9.0 ‡	.....	.....	1.175	.....
Mount Airy	Lovel's Creek	1.11	1.5	.....	0.405	1.000
Mount Holly	Catawba River	1774 ‡	1.0	.....	0.132	0.650
Murphy	Hiwassee River	410 ‡	0.5	.....	.....	.....
Newton	Hildebrand	.....	1.0	.....	.....	0.375
North Wilkesboro	Reddies River	90.0	1.0	.....	0.330	0.415
Old Fort	.....	.....	.....	.....	.....	.....
Oxford	Tar River	.....	1.5	.....	0.221	0.528
Pinehurst	Rattlesnake Branch	.....	0.700	.....	0.400	0.300
Raleigh	Walnut Creek	13.7	6.5	.....	3.043	2.600
Reidsville	Big Troublesome Creek	0.188	1.0	.....	0.321	0.625
Robbinsville	Long Br. and Stillhouse Br	0.79	.....	.....	.....	.....
Rockingham	N. Fork Falling Creek	*10.125	1.0	.....	.....	.....
Rocky Mount	Tar River	775 ‡	3.0	.....	.....	2.050
Roxboro	.....	.....	0.75	.....	0.150	0.500
Rutherfordton	Holland's Creek	.....	0.50	.....	0.213	0.150
Salisbury	Yadkin River	3100 ‡	3.0	.....	.....	0.984
Saluda	Pace's Creek—Springs	0.54	0.50	6″	.....	0.500
Sanford	Letts Creek	3.75	1.0	.....	0.449	0.405
Shelby	First Broad River	31.0	2.0	.....	0.381	0.190
Smithfield	Neuse River	2093 ‡	0.5	.....	.....	0.175
Southern Pines	Springs	0.017	1.0	.....	0.331	0.660
Spindale	Holland's Creek	.....	1.0	.....	0.555	0.665
Spruce Pine	Gracey Creek	0.65	.....	.....	0.328	0.100
Statesville	N. Fork, Fourth Creek	.....	1.5	.....	0.780	0.230
Sylva	Fishers Creek	0.67	.....	4″-8″	0.250	0.100
Tarboro	Tar River	2100 ‡	1.0	.....	.....	0.360
Thomasville	Abbott's Creek	.....	1.5	.....	0.361	0.800
Troy	Denson Creek	18.9	0.25	.....	0.070	0.375
Tryon	Long Fork Cr.—Colt Cr., Big Falls, Little Fall Cr.	.....	1.0	.....	0.090	0.240
Wadesboro	Flat Rock Branch	0.45	0.5	.....	.....	0.225
Wake Forest	Smith's Creek	3.5	0.25	.....	.....	0.111
Washington	Tranter's Creek	.....	1.0	.....	0.545	0.600
Waynesville	Rock Branch	14	0.75	.....	.....	0.350
Weaverville	Waltons Cr.—Ox Cr	0.47	.....	4″-6″	0.040	0.100
Weldon	Roanoke River	8180 ‡	1.0	.....	0.168	0.192
West Hickory	From Hickory Supply.					
Wilkesboro	From North Wilkesboro.					
Wilmington	Cape Fear River	.....	6.0	.....	3.367	1.145
Wilson	Contentnea Creek	.....	3.0	.....	1.257	1.175
Winston-Salem	Middle Fork Cr.	25.2	12.0	.....	.....	7.500
Zebulon	Little River	.....	0.25	.....	.....	0.163

‡From records of Water Resources Division, N. C., Dept. of Conservation and Development.

PART IV.

INDUSTRIAL IMPORTANCE OF MINERAL CONSTITUENTS FOUND IN NATURAL WATERS

The following remarks on the importance of the chemical constituents found in surface waters and their industrial implications are all excerpts from Water Supply Paper 496 of the U. S. Geological Survey, by W. D. Collins, entitled "The Industrial Utility of Public Water Supplies in the United States".

Silica.—Silica is dissolved from practically all rocks. Its state in natural water is not definitely known, but in reports of analyses it is assumed to be in the colloidal state, taking no part in the equilibrium between the acids and the bases.

Coagulation with aluminum sulphate makes possible the removal of fine silt by sedimentation and filtration, so that the effluents of filter plants contain less silica than untreated waters filtered through paper, and in considering the analyses of river waters used for a city supply that is filtered after the use of a coagulant it must be borne in mind that the quantity of silica is reduced by the filtration. The silica in most filtered waters is not so high as 10 parts per million, and in some it is less than 5.

As an insoluble constituent the silica in water contributes to the formation of boiler scale, and it sometimes helps to cement the other materials into a hard scale. Its presence or absence is said to have an effect on some of the exchange-silicate water-softening materials. On the whole, however, silica is of comparatively little importance in the waters of public supplies.

Iron (iron and aluminum oxides).—Iron is dissolved from practically all rocks and is frequently dissolved from iron pipes in sufficient quantity to be objectionable.

Iron is reported in all the analyses made by the United States Geological Survey and in most of the others. The figures given as iron in some analyses represent, as is shown by a footnote, the quantity of iron and aluminum oxides. They do not show the minimum limit of the iron, but they do show its maximum limit, for the iron can not be more than 0.7 times the oxides.

Few surface waters contain in solution as much as 1 part per million of iron. In most of them the quantity is nearer 0.1 part. Many ground waters contain several parts per million of iron, which must be removed in order to make the waters satisfactory

for domestic and industrial use. Water that contains much iron is objectionable on account of its appearance after exposure to the air and on account of the unsightly stains it makes on white porcelain or enameled ware or fixtures and on clothing or other fabrics washed in it. Smaller quantities of iron are said to cause trouble in the use of certain dyes. Excessive iron may interfere with the efficient operation of exchange-silicate water softeners.

Iron is almost completely removed by filtration as practiced at water-purification plants, but the treatment sometimes leaves the water in such condition that it can and does dissolve iron from pipes, particularly hot-water pipes. Some natural waters also have this property.

Aluminum is found only in negligible quantities in most natural waters. Under certain conditions of operation aluminum may pass through filters but in quantities too small to affect seriously the industrial use of the water.

Calcium and magnesium.—Though calcium and magnesium have somewhat different properties their effects upon the industrial uses of water are so much alike that they can not well be treated separately. They cause hardness in water and together with the acid radicles in equilibrium with them make up from 60 to 90 per cent of the mineral matter of hard waters. Calcium and magnesium are also the predominating basic radicles in most soft waters.

The general industrial value of waters used for public supplies is more affected by calcium and magnesium than by any other constituents.

Sodium and potassium.—The sodium and potassium in the water of most public supplies have little effect on the industrial use of the water. Natural waters that contain only 3 or 4 parts per million of the two together are likely to contain about equal quantities of sodium and potassium. As the total quantity of these constituents increases, the proportion of potassium becomes less: waters carrying from 30 to 50 parts per million of the two may contain from 4 to 10 times as much sodium as potassium; waters carrying more sodium may contain smaller proportions of potassium.

Bicarbonate.—The usual methods of analysis lead to the con-

clusion that the carbon dioxide in most natural waters is present as bicarbonate (HCO_3) and free carbon dioxide (CO_2). A few natural waters contain little carbon dioxide and therefore show carbonate radicle (CO_3), which may be found also in water raised by an air lift that tends to sweep the carbon dioxide out of it. Many waters that have been treated with lime contain carbonate or even hydroxide. Some analyses show the composition of the residue on evaporation and therefore give carbonate instead of bicarbonate. In some partial analyses alkalinity is reported in terms of calcium carbonate ($CaCO_3$).

For uniformity and simplicity all results of determinations of alkalinity, whether expressed in terms of bicarbonate (HCO_3), carbonate (CO_3), or as equivalent calcium carbonate ($CaCO_3$), are given in this report as bicarbonate (HCO_3). The small quantities of carbonate found in some samples may be due to the action of the sample on the bottles.

Bicarbonate is the chief acid radicle in nearly all the waters used for public supplies.

Sulphate.—Sulphate is not a very important constituent of the water of most public supplies. The quantity present affects the softening of the water and is affected by treatment with coagulants. An analysis of a river water before filtration will therefore show a smaller quantity of sulphate than that in the filtered water. A part of the sulphate in the water of some sources of supply is contributed to it by human activities. Many supplies in Pennsylvania receive sulphuric acid from the drainage of mines, even enough to make the waters acid, and some waters that are used for public supplies are contaminated by sulphuric acid or sulphates discharged from industrial establishments.

Chloride.—The water of only a few public supplies contains enough chloride to have any effect on its use for most industrial processes. The addition of chlorine or hypochlorite has no practical effect on the quantity of chloride radicle in a water. The chloride contributed by most rocks to a natural water rarely amounts to as much as 10 parts per million. Larger quantities are usually the result of contamination with water from deep wells or from deposits of common salt. Some industrial plants discharge chlorides, and a considerable quantity is added to many rivers by sewage from large cities.

Nitrate.—The effect of nitrate on the industrial use of water obtained from public supplies is so nearly negligible that results of determinations of nitrate could be omitted from the tables without great loss. A few waters contain enough nitrate to affect the calculated quantity of sodium or to increase the apparent error in an analysis in which sodium is determined and nitrate is not reported.

HARDNESS

Hardness in water is produced by calcium and magnesium. Other elements, such as iron, aluminum, strontium, or barium, would cause hardness, but these are not found in the water of public supplies in quantities large enough to have any appreciable effect.

Hardness may be recognized by the increased quantity of soap required to produce lather and by the deposits of insoluble salts formed when a hard water is heated or evaporated. Hardness may be determined by the use of a standard solution of soap. . . . . Although this method is not wholly reliable for some kinds of water, it should give accurate results with waters like most of those for which analyses are given.

Hardness can in general be determined more reliably by calculation than by the use of a soap solution. The hardness as equivalent calcium carbonate ($CaCO_3$) is 2.5 times the calcium plus 4.1 times the magnesium.

Hardness is by far the most important property of a water with reference to its general industrial utility.—Collins, W. D.

REQUIREMENTS OF WATER USED FOR INDUSTRIAL PURPOSES

Various industries have established large plants in North Carolina because of the fine quality of water. A number of others are planning to locate in the State and still others are considering it as a suitable location. These specific industries require exceptionally pure water. Among such industries may be mentioned those for the manufacture of paper, fine textiles, rayon, leather, bleacheries, dye houses, and laundries. The following few examples will show the relation of certain important industries to impurities in water:

PAPER MANUFACTURE

It requires from 10,000 to 400,000 gallons of water to produce one ton of paper. The nature of the water is not very important for making brown craft and wrapping paper. In the digestion of the pulp the alkalies precipitate ferric hydroxide from any iron in the water. This precipitate gives a brown color to the pulp and paper. During the sizing also rust spots from the iron prevent the production of white paper since bleaching does not remove these iron splotches. Sizing the paper consists in precipitating aluminum resinate on the fibres of the paper. Calcium in the water reacts with the resin soap as alum does, but the precipitate is more granular and does not adhere to the fibers. Alkaline waters form double salts with the alum which do not react with the resin soap to make a good size. Turbid waters protect the fibers in places from the action of the bleach, and the finished paper has specks and spots. Acid waters interfere with the size, decompose the dyes, and corrodes the screen wire. It is natural therefore that papermakers must consider the quality of the water to be used. Iron may be removed by simple aeration if there are no reducing agents present, but if much organic matter is present an oxidizing filter will remove the iron. It is most desirable to have water which does not require softening. The surface waters of North Carolina generally require no treatment for this exacting industry other than the usual filtration to remove turbidity. The quality of water together with other advantages, and a plentiful supply of raw materials caused the locating of one of the largest paper industries in the United States at Canton in Western North Carolina, and another paper mill at Roanoke Rapids in the eastern part of the State. These pulp and paper mills were established more than twenty years ago. A new one of considerable importance is now being erected in Sylva on Scotts Creek.

DYEING AND BLEACHING

Water for dyeing and bleaching should be free from suspended matter, soft, and free from iron. Iron cannot be present in waters used for dyeing with alizarin or any coal tar colors which are fixed on a tannin mordant. Calcium and magnesium cause

uneven dyeing spots and splotches, waste of color, and other similar troubles, such as unevenness of colors. For light shade dyeing particularly, the water must be free from iron and hardness.

TANNING

In tanning leather the hides are soaked in lime water to remove the hair and to saponify the fatty tissues on the under side of the hide. The excess lime is washed off before the hides are put into the tanning tanks. If bicarbonates or carbonic acid are present in the water the lime is precipitated in the tissues of the hide. These deposits protect the hide from the tanning action of the tan liquor which should unite with the hide to make such a combination as is practically free from decay under ordinary conditions. Iron unites with the tannin to make a black ink so that nothing but black leather may be made. Chlorides prevent the proper swelling or plumping of the leather. Organic matter cannot be present because it is subject to decay and prevents the proper tanning of the leather.

INDUSTRIAL UTILITY OF NORTH CAROLINA WATERS

The illustrations given above show how careful many industries must be to find a suitable water, or to treat a water not entirely appropriate for their needs. Inspection of the analyses of North Carolina surface waters presented in this paper will clearly indicate the numerous sources in this State which in their natural condition, or with the minimum of treatment, will meet the most drastic requirements for manufacturing and industrial use.

APPENDIX

A. METHODS OF ANALYSIS

Relative to the methods of analysis used in making the determinations reported on herein by the United States Geological Survey, Margaret D. Foster, analyst, made the following statement in her article "Surface Waters of Western North Carolina," which appeared in the July, 1927, number of Industrial and Engineering Chemistry:

The analyses were made by the methods regularly used for the analysis of water in the United States Geological Survey, which are essentially the same as those recommended by the American Public Health Association and published in "Standard Methods of Water Analysis".

Alkalinity and chloride were determined by titration according to the usual analytical procedures. No carbonate was found in any sample. Nitrate was determined by the phenoldisulfonic acid method.

Suspended matter was determined by filtering a measured volume of the sample through asbestos in a Gooch crucible and weighing the residue after drying to constant weight at 180° C. Turbidity was determined in a Jackson turbidimeter or, on the clearer waters, by comparison with standard silica turbidities in bottles. Color was determined on a filtered sample of the water by comparison with standard color disks.

One or two liters of the filtered water were evaporated to dryness in a platinum dish, and the residue upon evaporation, after drying an hour at 180° C., was weighed as the "total dissolved solids." Silica was separated by evaporation with hydrochloric acid. Iron was determined colorimetrically as the thiocyanate, and calcium by titration as the oxalate with potassium permanganate. Magnesium was precipitated and weighed as pyrophosphate.

Sulfate was determined as barium sulfate on another portion of 1 or 2 liters of the filtered water which had been evaporated down to a suitable volume. The sulfate filtrate, after the removal of calcium, magnesium, and barium, was evaporated to dryness, and the residue was weighed as the mixed chlorides of sodium and potassium. Potassium was determined by weighing the platinum resulting from the reduction of potassium platinic

chloride. The sodium in the mixed chlorides was found by difference.

The percentage error of each analysis was calculated by dividing the difference between the equivalents of the bases and the acids by the sum of the equivalents. The calculations showed all the analyses to be well within the limits that are allowed for careful analytical work.

Dr. E. E. Randolph spent some time in Washington consulting with members of the chemical staff of the U. S. Geological Survey and observing the details of the methods which they were using in the analysis of water. In transmitting his analyses to the director he has stated that his methods of analyses were identical with those used in the laboratory of the Survey.

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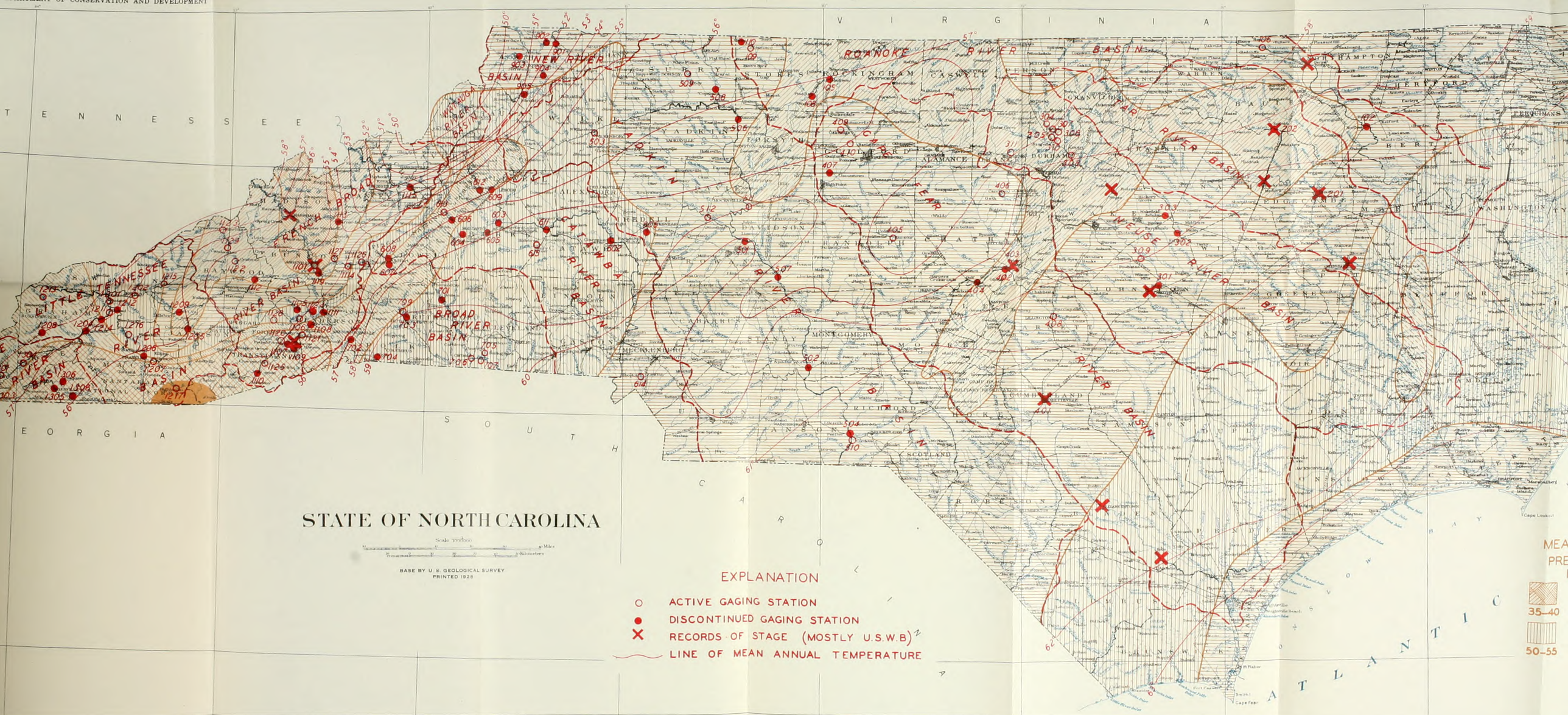
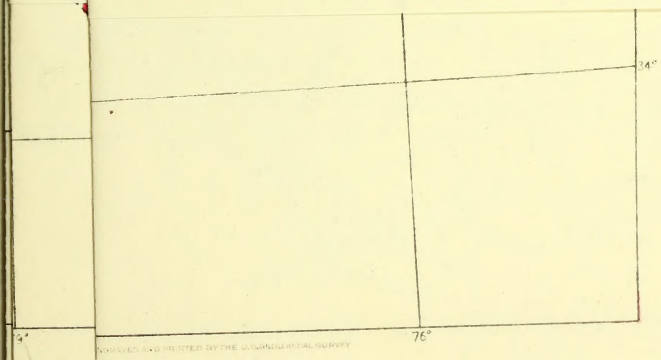


MAP OF NORTH CAROLINA SHOWING STREAM GAGING STATIONS, WITH RAINFALL AND TEMPERATURE DATA

PREPARED BY

WATER RESOURCES DIVISION, N. C. DEPARTMENT OF CONSERVATION AND DEVELOPMENT

1928



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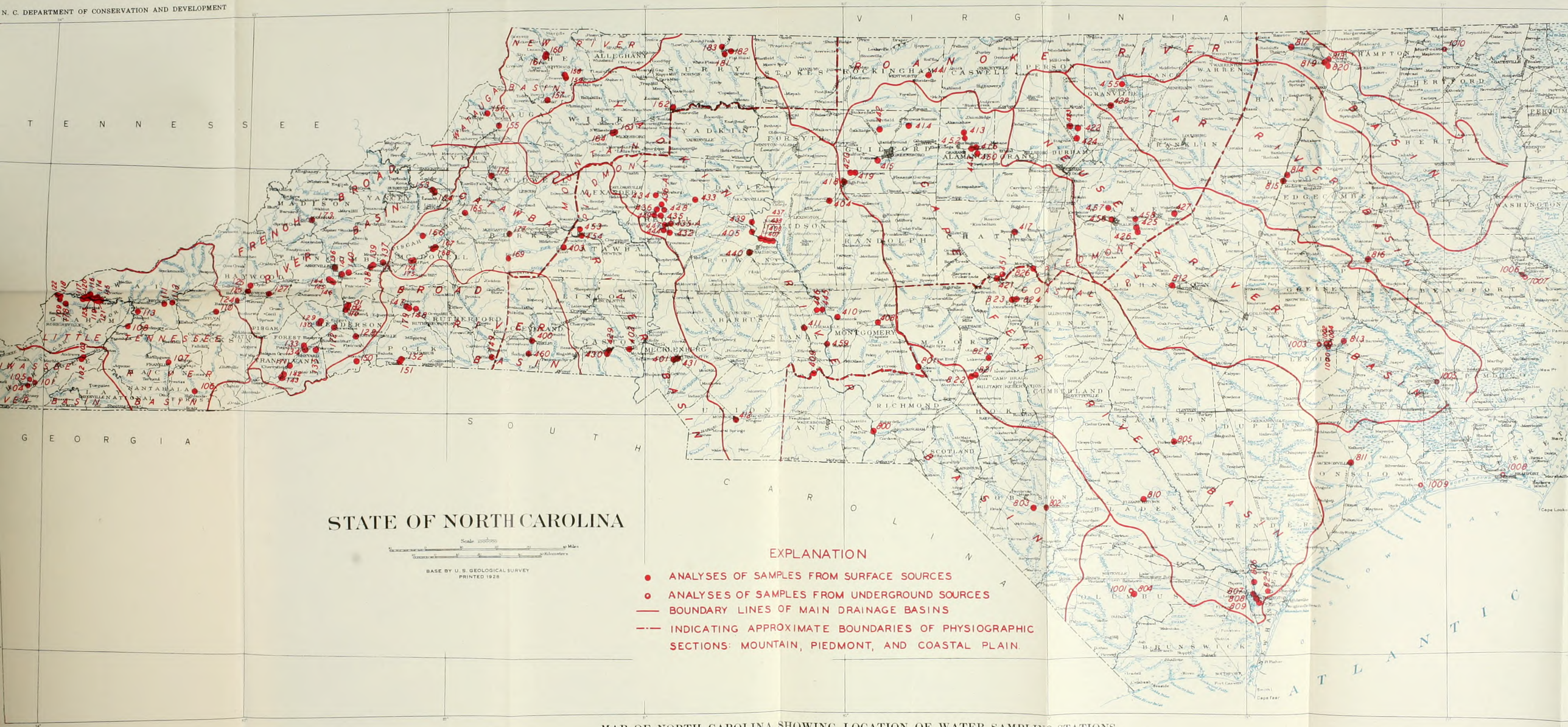
N. C. DEPARTMENT OF CONSERVATION AND DEVELOPMENT



MAP OF NORTH CAROLINA SHOWING LOCATION OF WATER SAMPLING STATIONS

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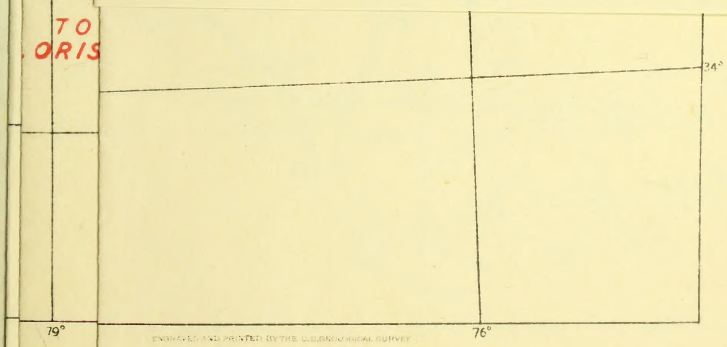
1928


34°
79°
76°

STATE OF NORTH CAROLINA

Scale (modern) Miles / Kilometers

BASE BY U. S. GEOLOGICAL SURVEY
PRINTED 1926

OWNERSHIP

2 ELECTRIC BOND & SHARE CO.
2B NATIONAL POWER & LIGHT CO.
2B1 CAROLINA POWER & LIGHT CO.
4 DUKE POWER CO.
14 STONE & WEBSTER CO.
14A ENGINEERS PUBLIC SERVICE CO.
14A1 VIRGINIA ELECTRIC & POWER CO.
16 INSULL GROUP.
16B NATIONAL ELECTRIC POWER CO.
16B1 NATIONAL PUBLIC SERVICE CORPORATION
16B1b TIDE WATER POWER CO
16B1c VIRGINIA PUBLIC SERVICE CO.
M MUNICIPAL
R RURAL
S MISCELLANEOUS POWER COMPANIES
T ALUMINUM COMPANY OF AMERICA.
T1 TALLASSEE POWER CO.

EXPLANATION

- HYDRO-ELECTRIC STATION.
- HYDRO-ELECTRIC STATION UNDER CONSTRUCTION
- STEAM STATION
- 132,000 VOLTS
- 110,000 - 100,000 VOLTS
- 60,000 - 44,000 VOLTS
- 33,000 - 22,000 VOLTS
- 13,000 - 11,000 VOLTS
- 6600 VOLTS
- 2,300 - 2,200 VOLTS

POWER MAP OF NORTH CAROLINA
PREPARED BY
WATER RESOURCES DIVISION, N. C. DEPARTMENT OF CONSERVATION AND DEVELOPMENT
1928